

ULTRAVIOLET ASTRONOMY IN THE XXI CENTURY



e-Workshop 2020 – October 27-29

The high-energy environment and atmospheric escape of small exoplanets

Leonardo A. dos Santos

PhD candidate, University of Geneva (*in the job market, available Fall 2021*)

In collaboration with D. Ehrenreich, V. Bourrier & the PanCET team



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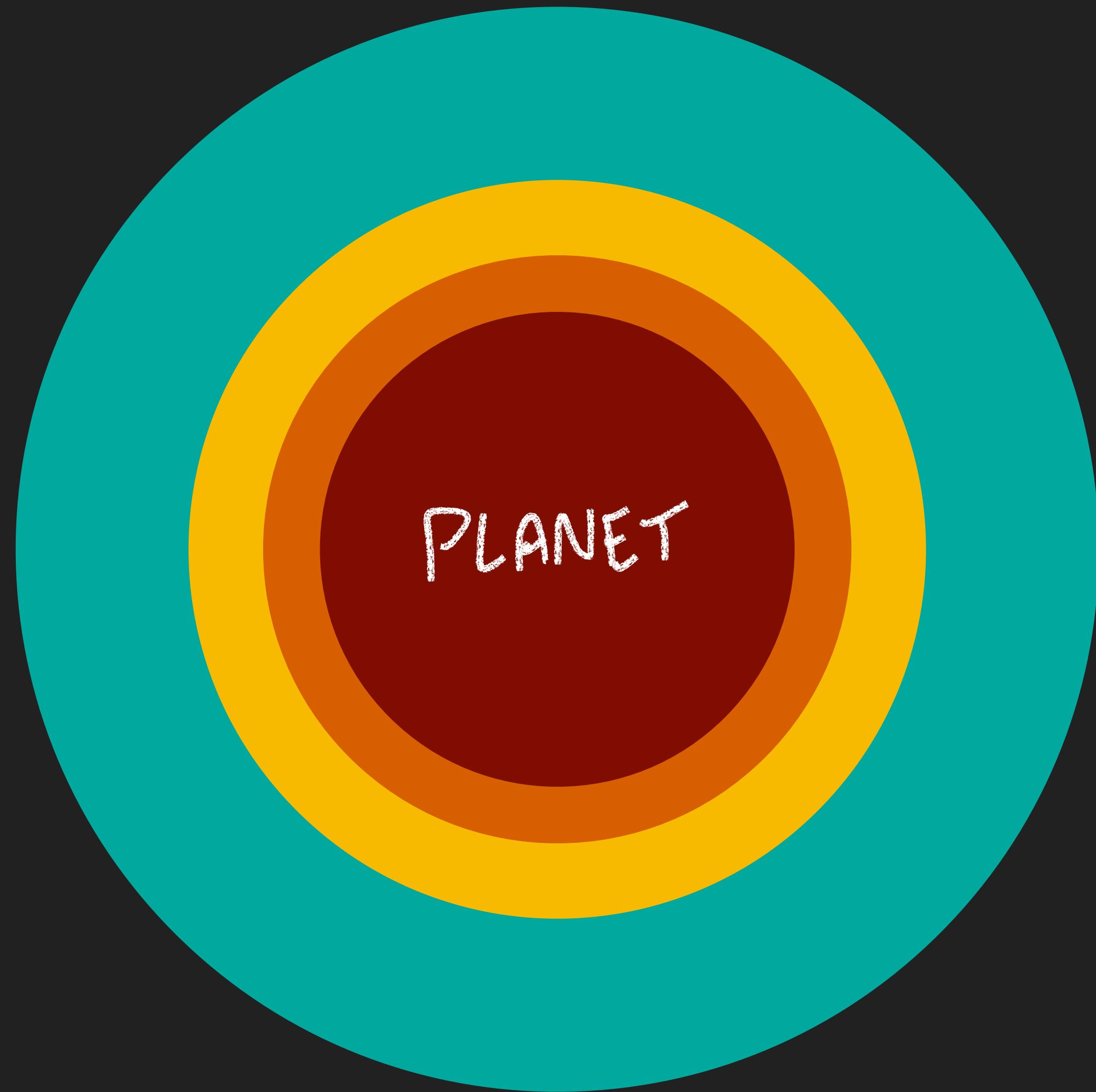


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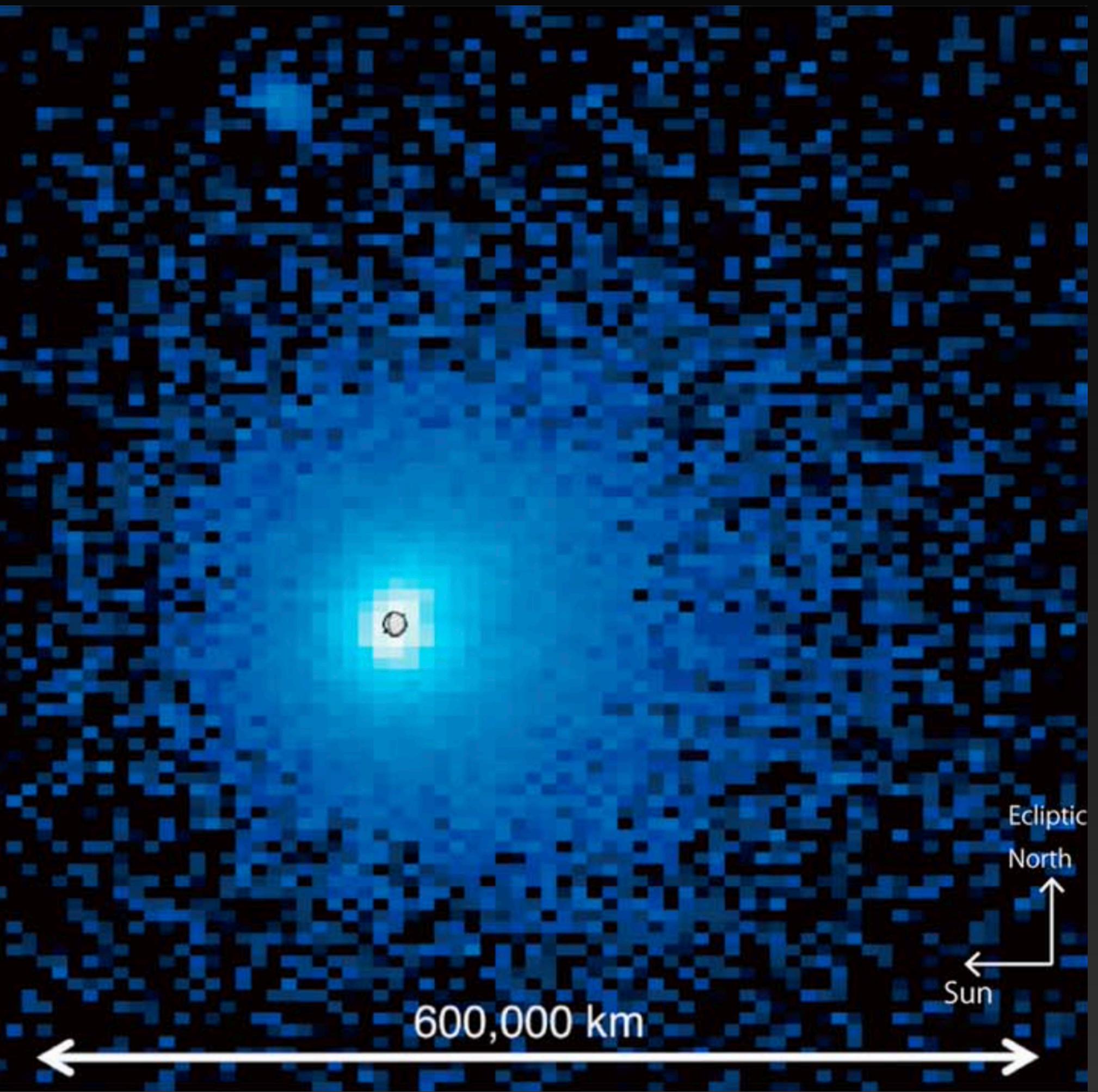
COLLISIONLESS
REGIME

ExOSPHERE

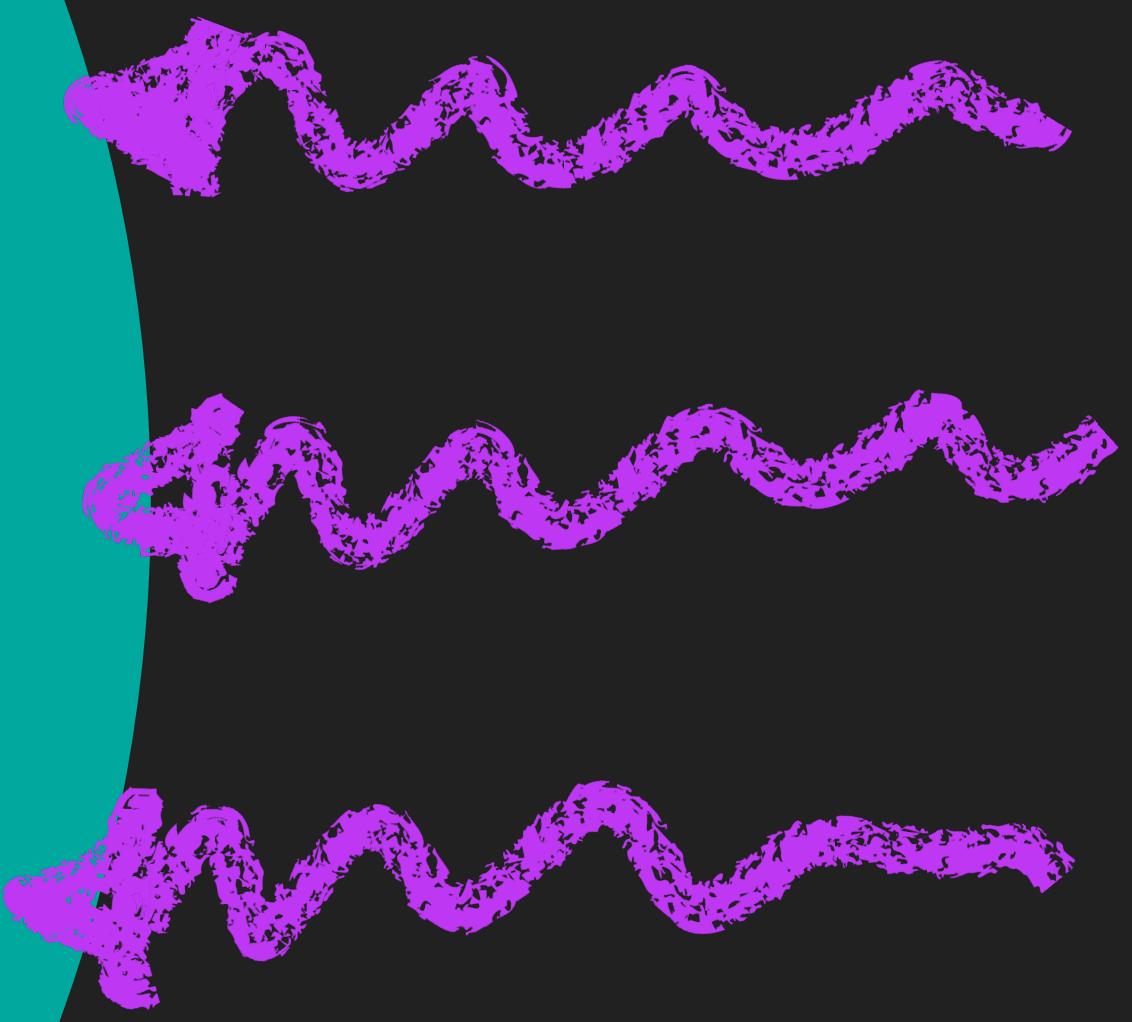
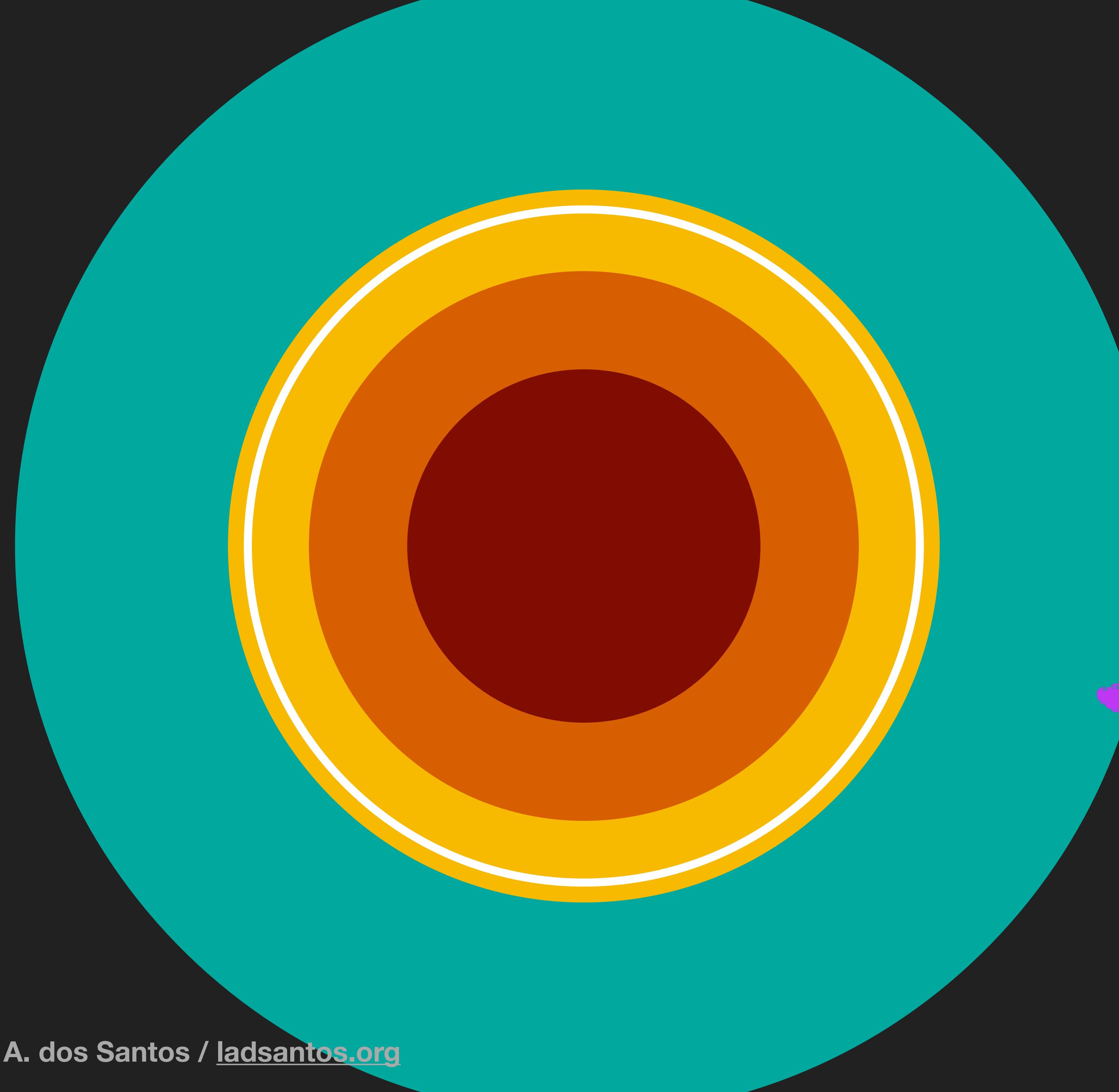
UPPER
ATMOSPHERE

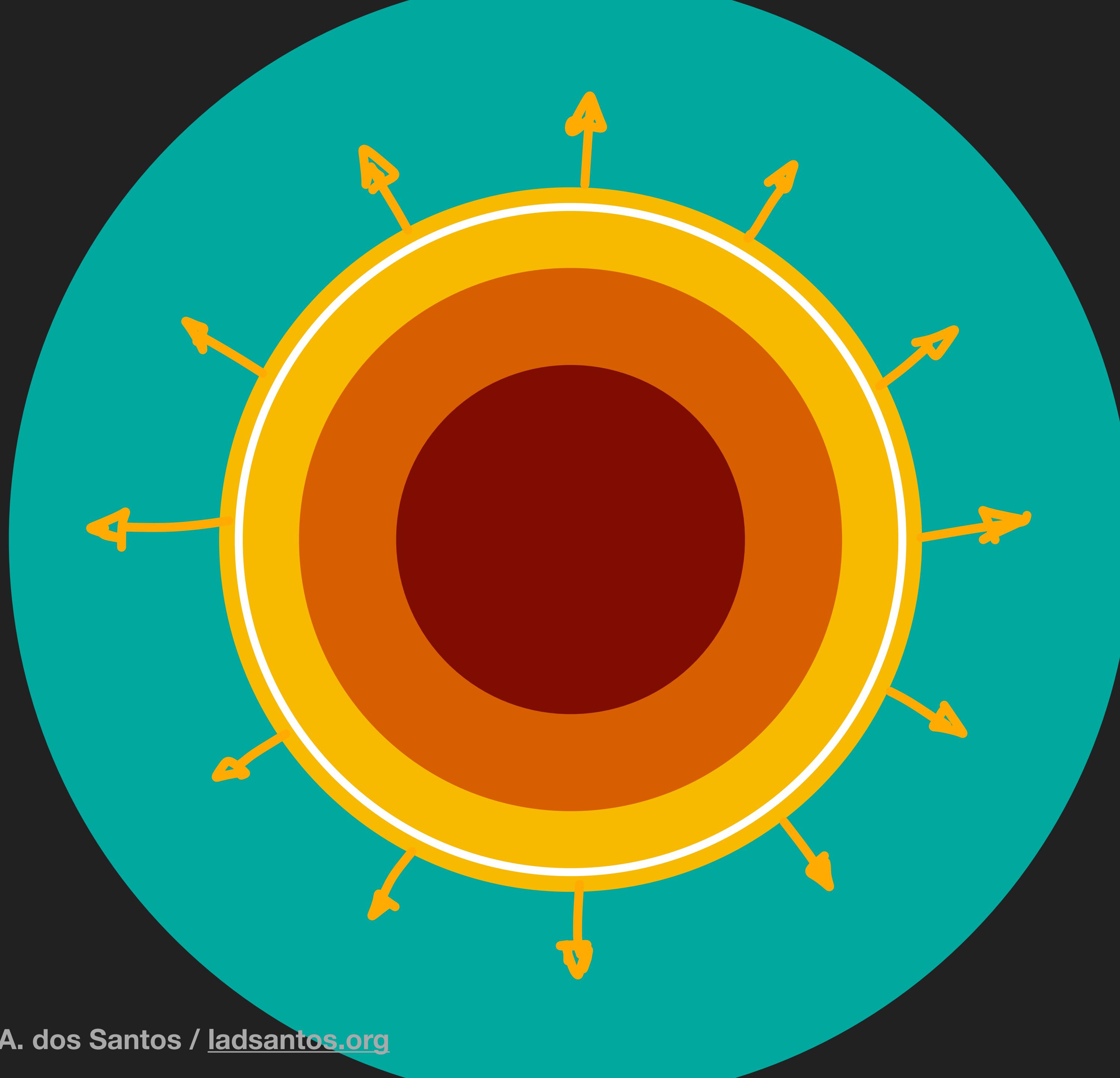
LOWER
ATMOSPHERE

COLLISIONAL
REGIME



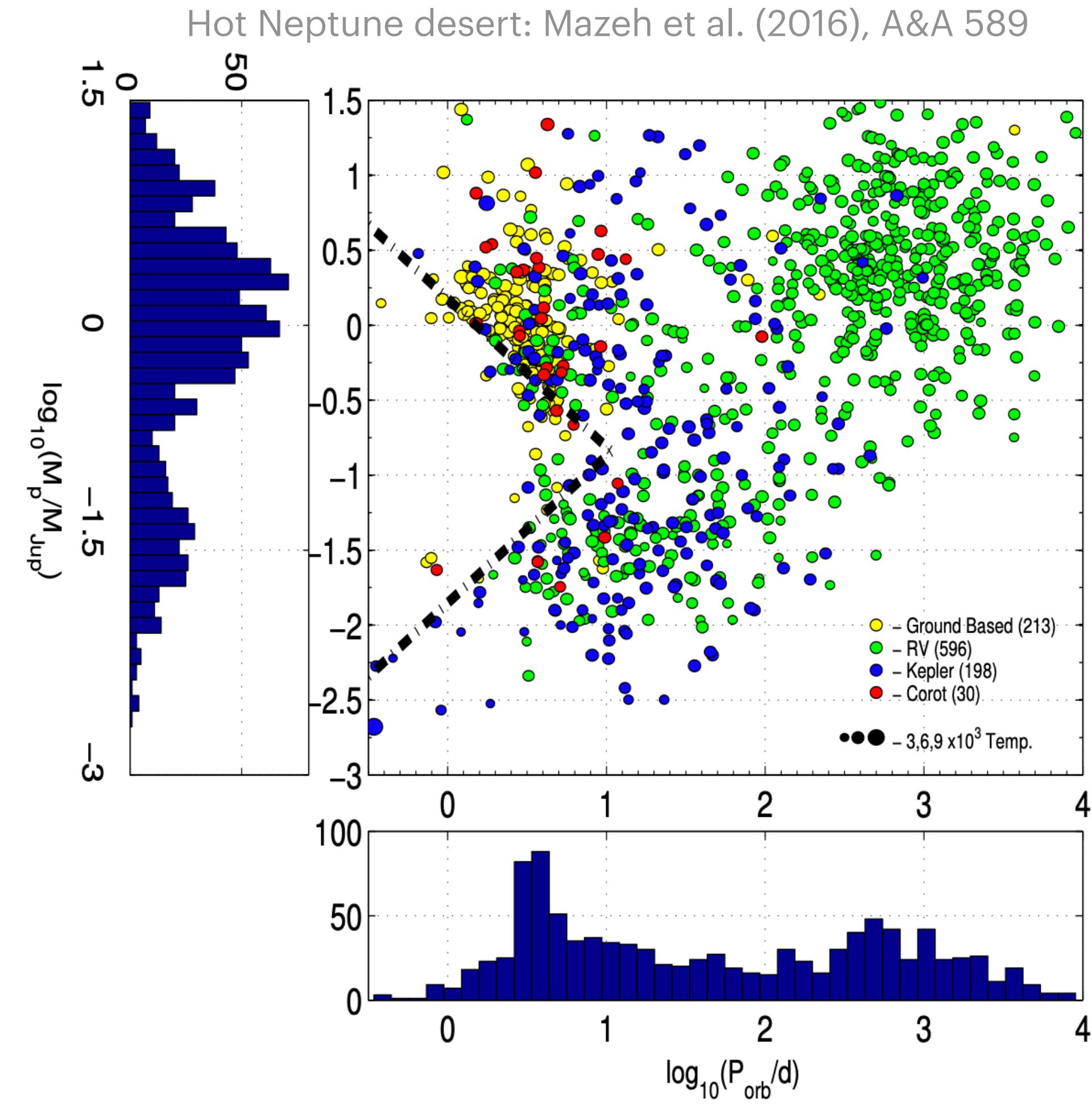
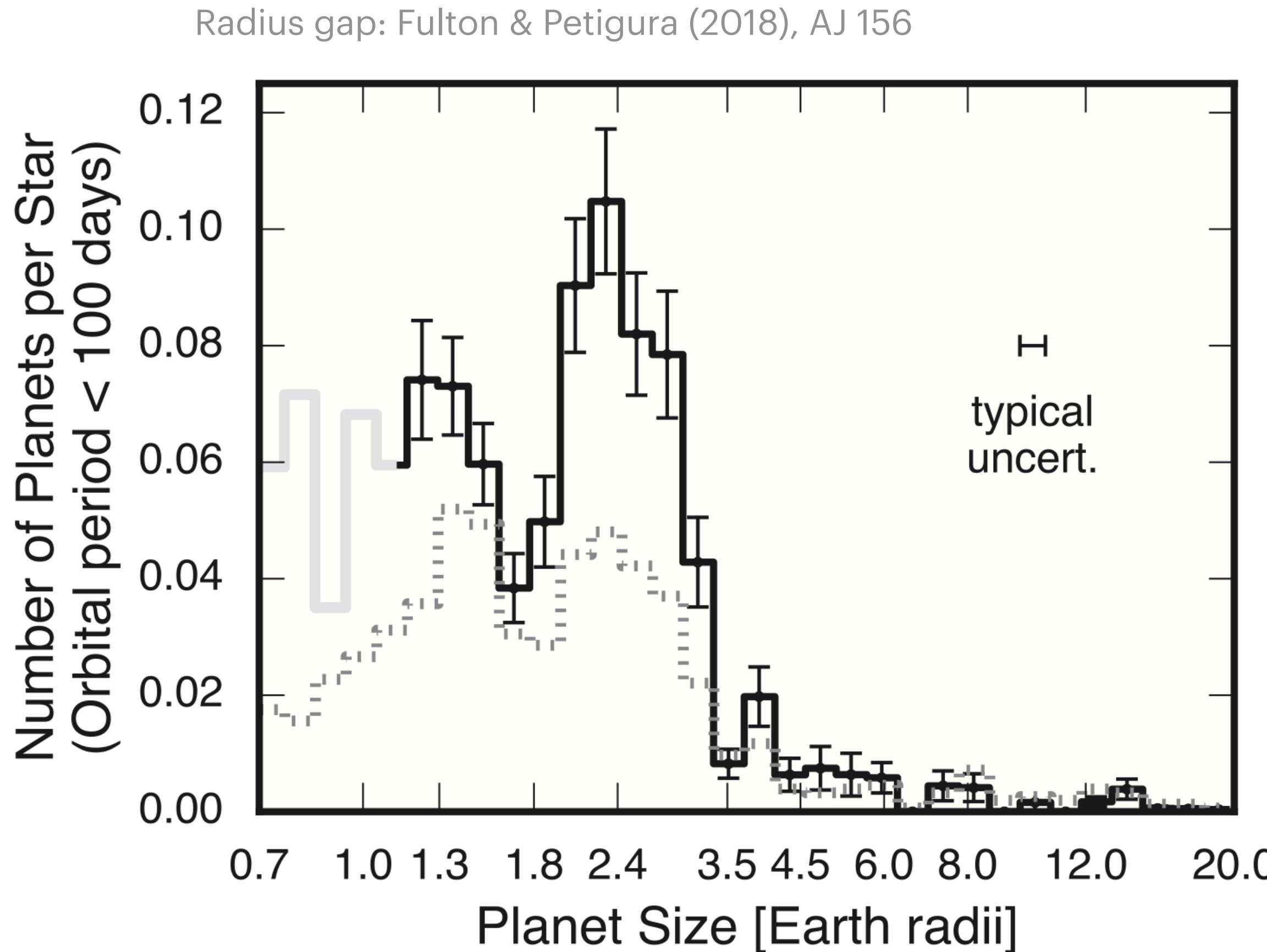
The H-rich exosphere of the Earth observed from space.
Kameda et al. (2017), GRL 44.





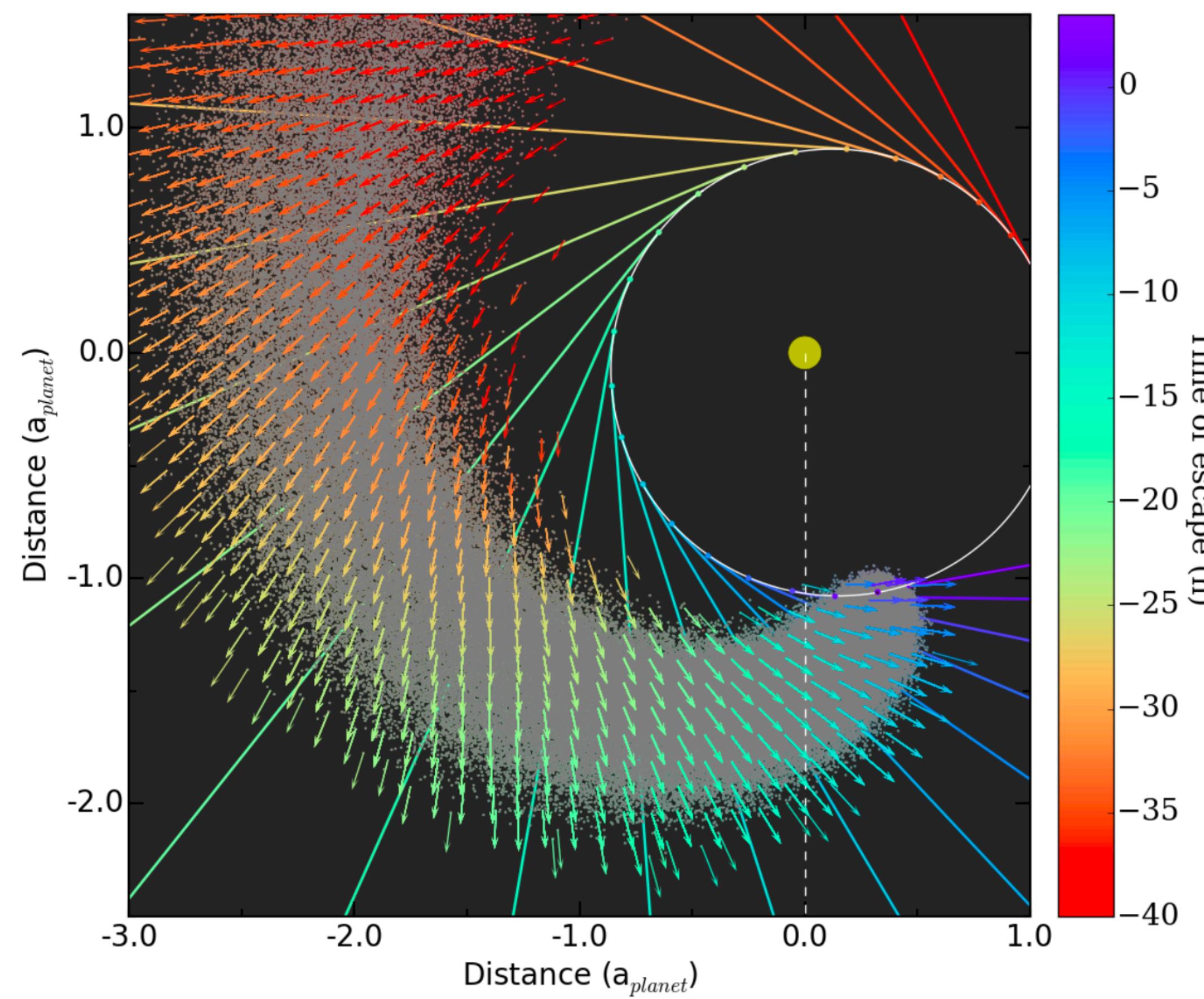
HYDRO
DYNAMIC
ESCAPE

Atmospheric escape imprints features in the exoplanet population

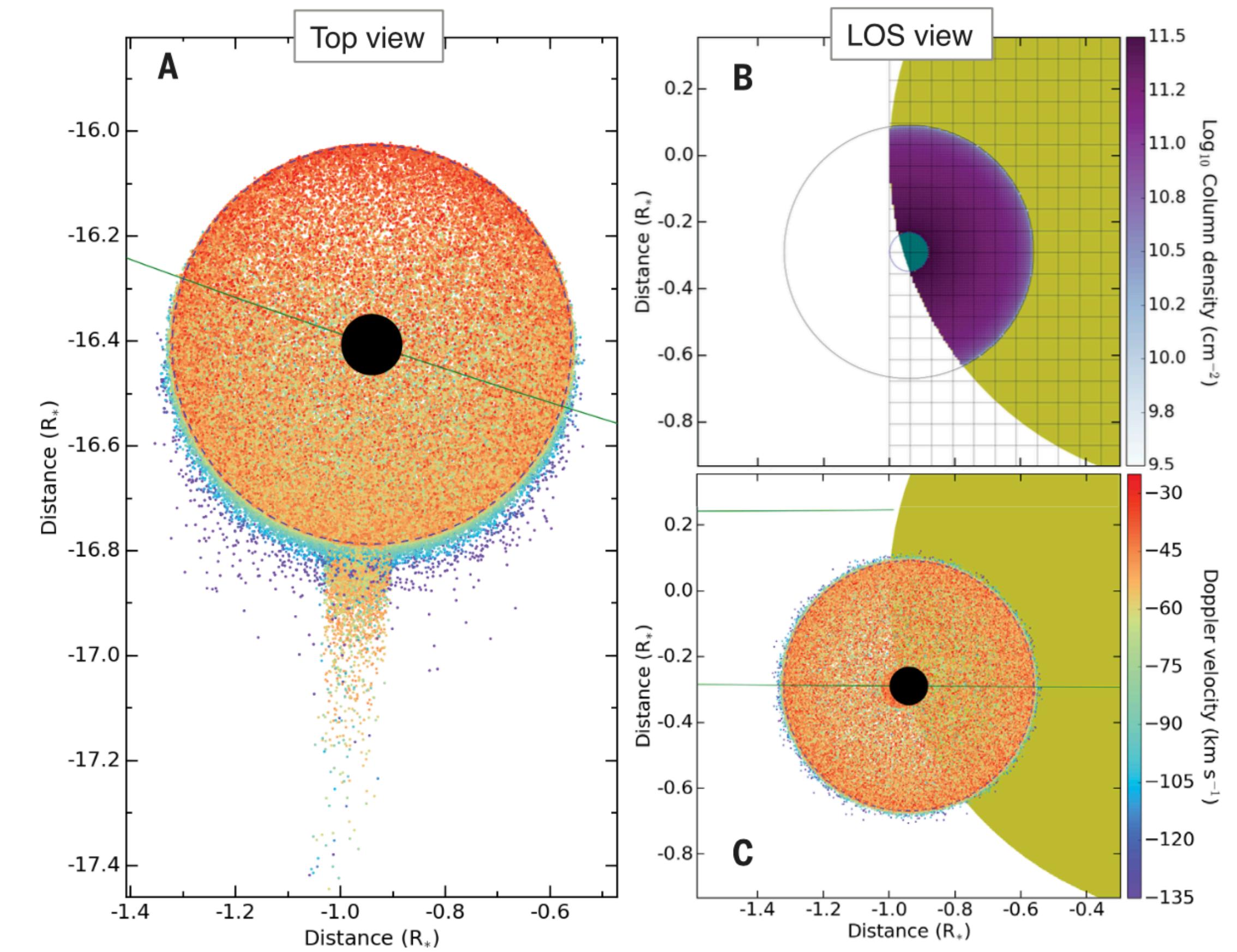


Atmospheric escape detections inform on mass loss rates and dynamics

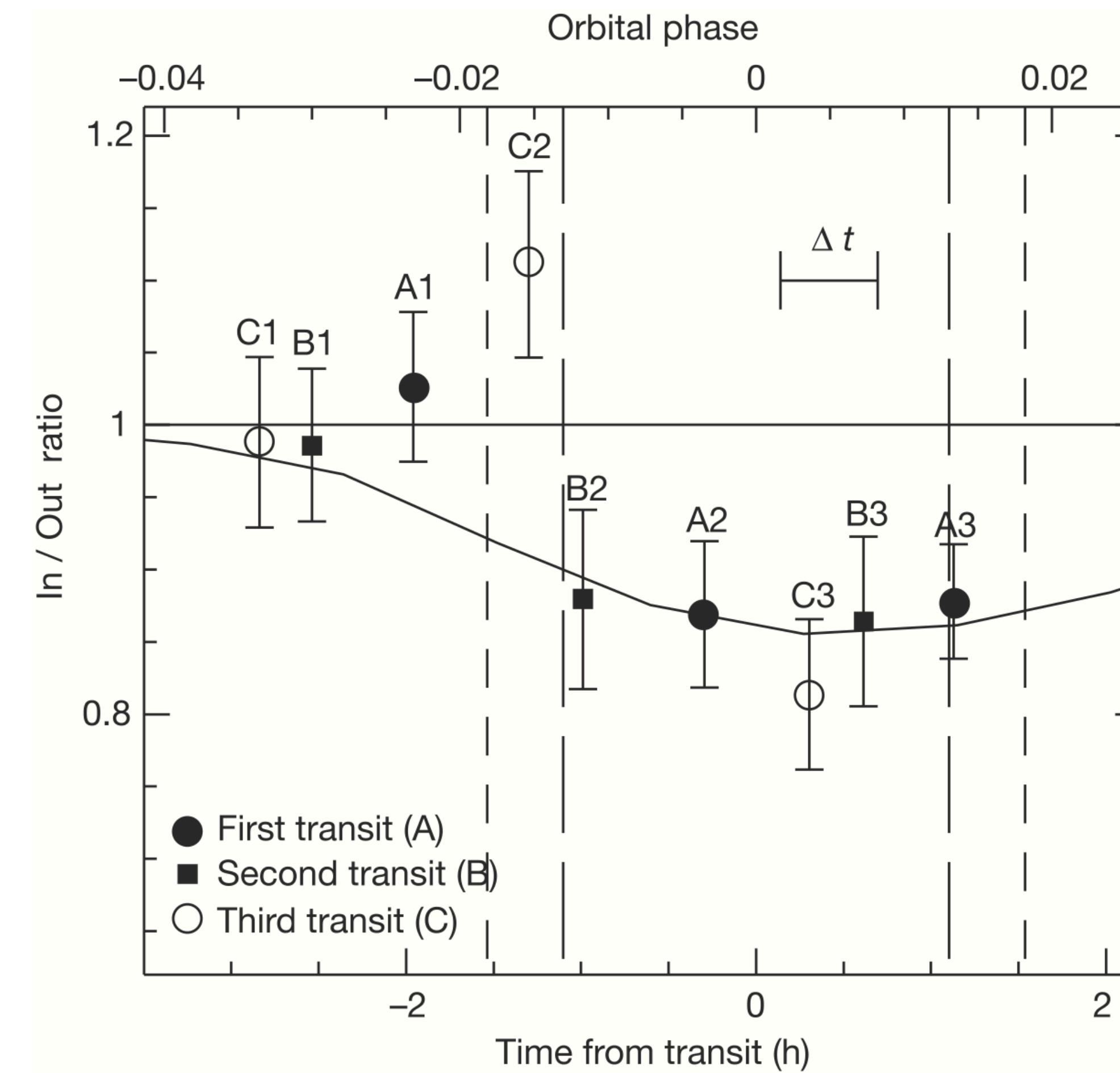
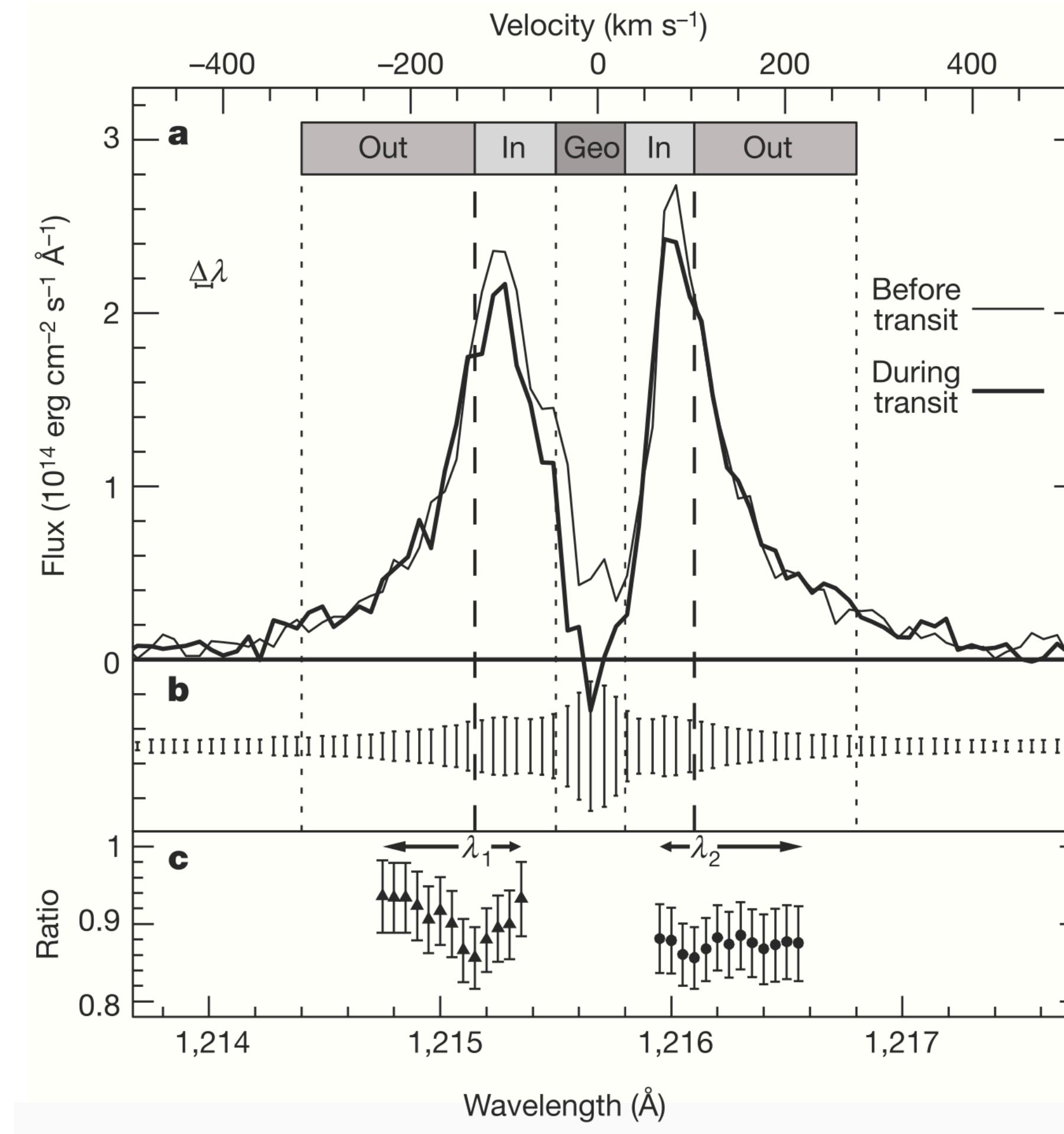
Dynamics in the exosphere of GJ 436 b:
Bourrier et al. (2015), A&A 582



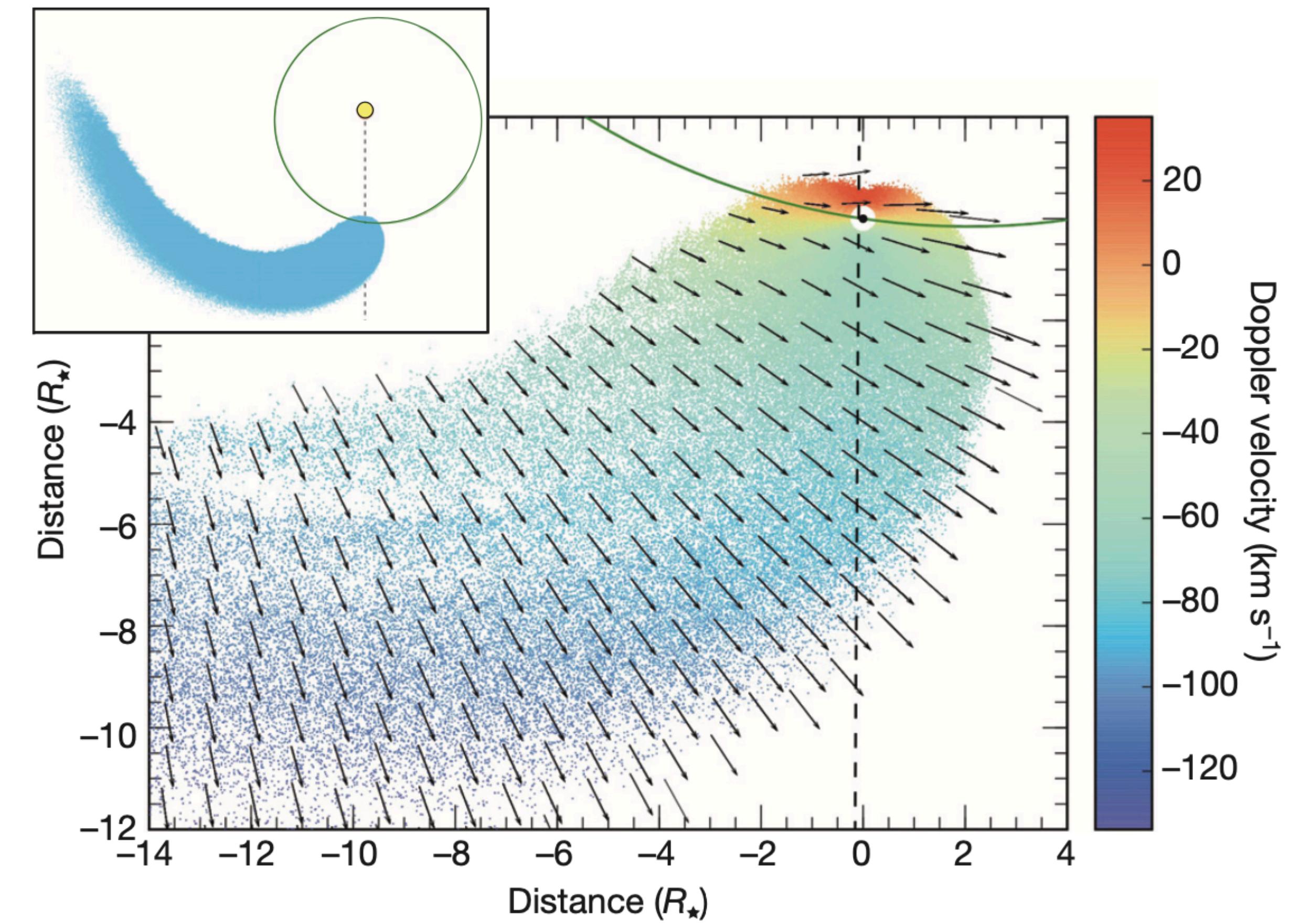
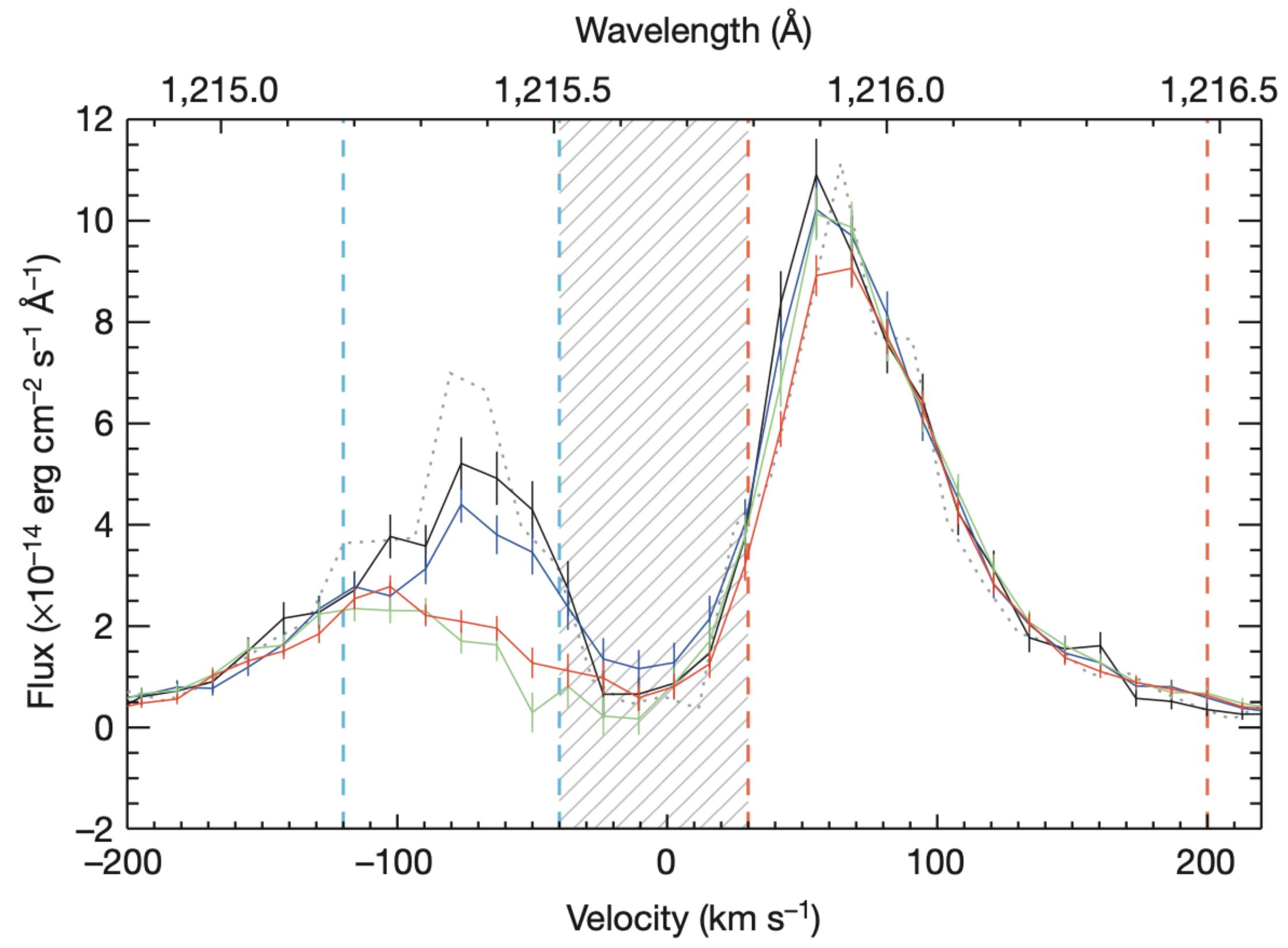
Dynamics in the upper atmosphere of HAT-P-11 b:
Allart et al. (2018), Science 362



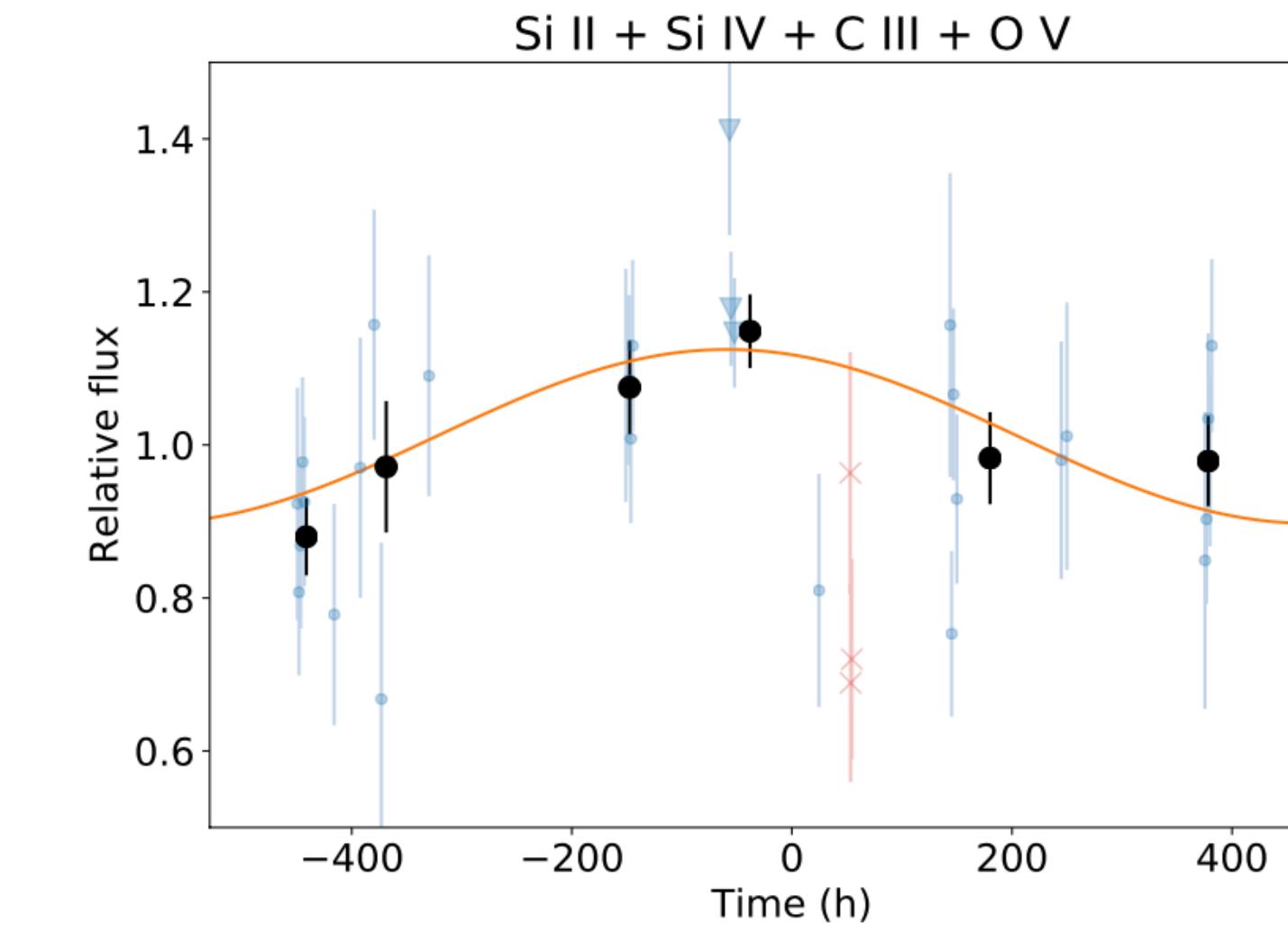
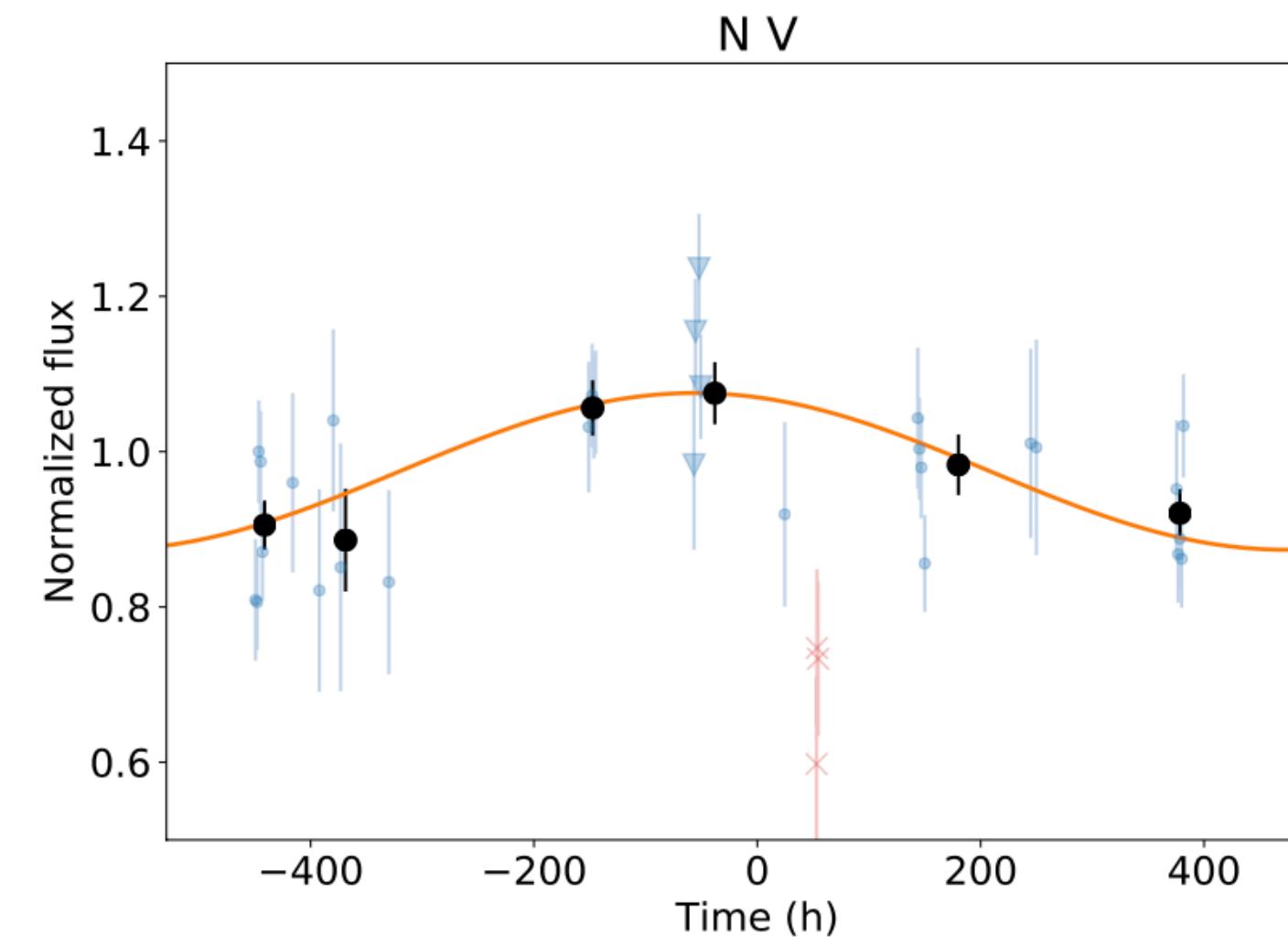
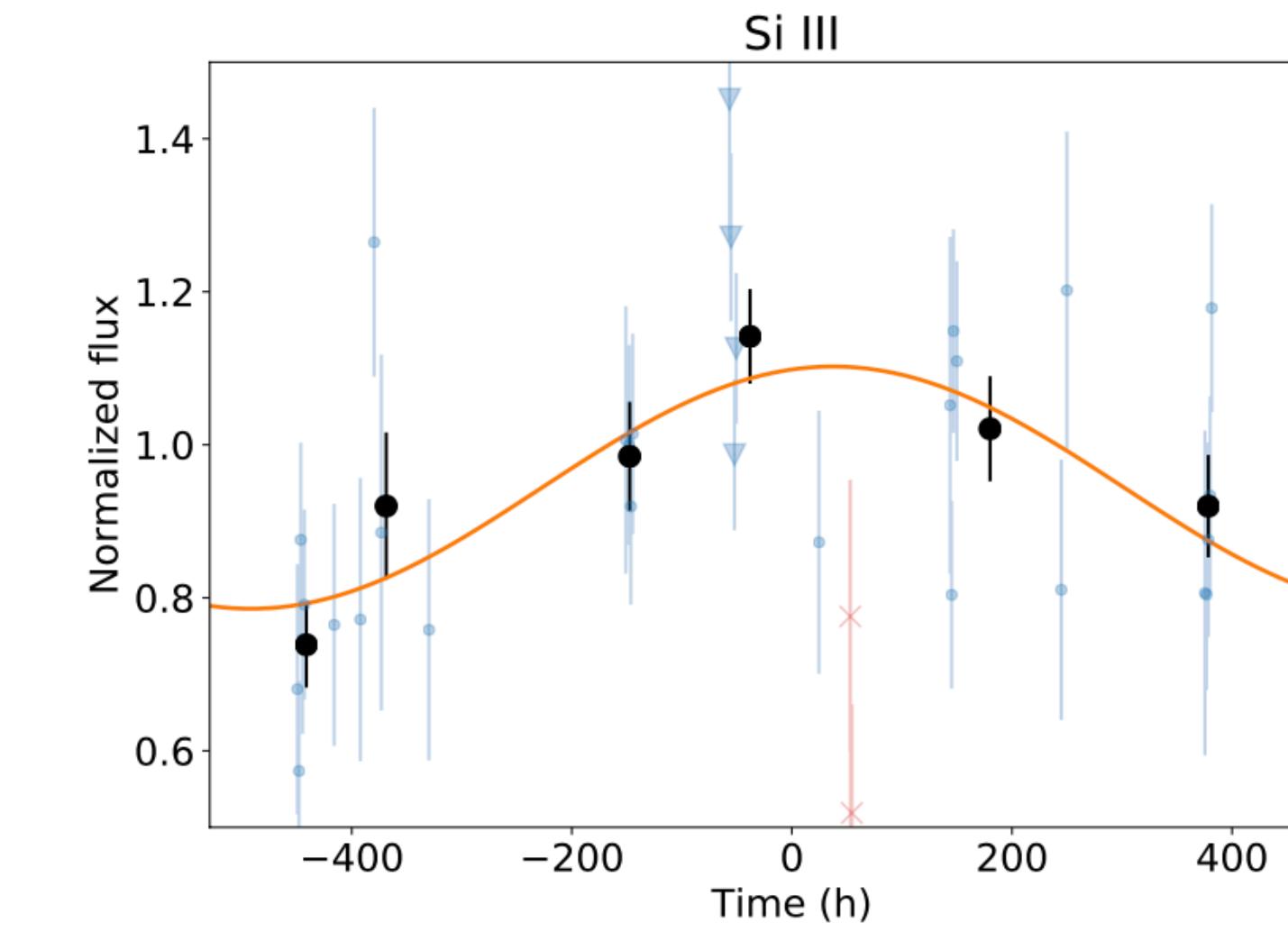
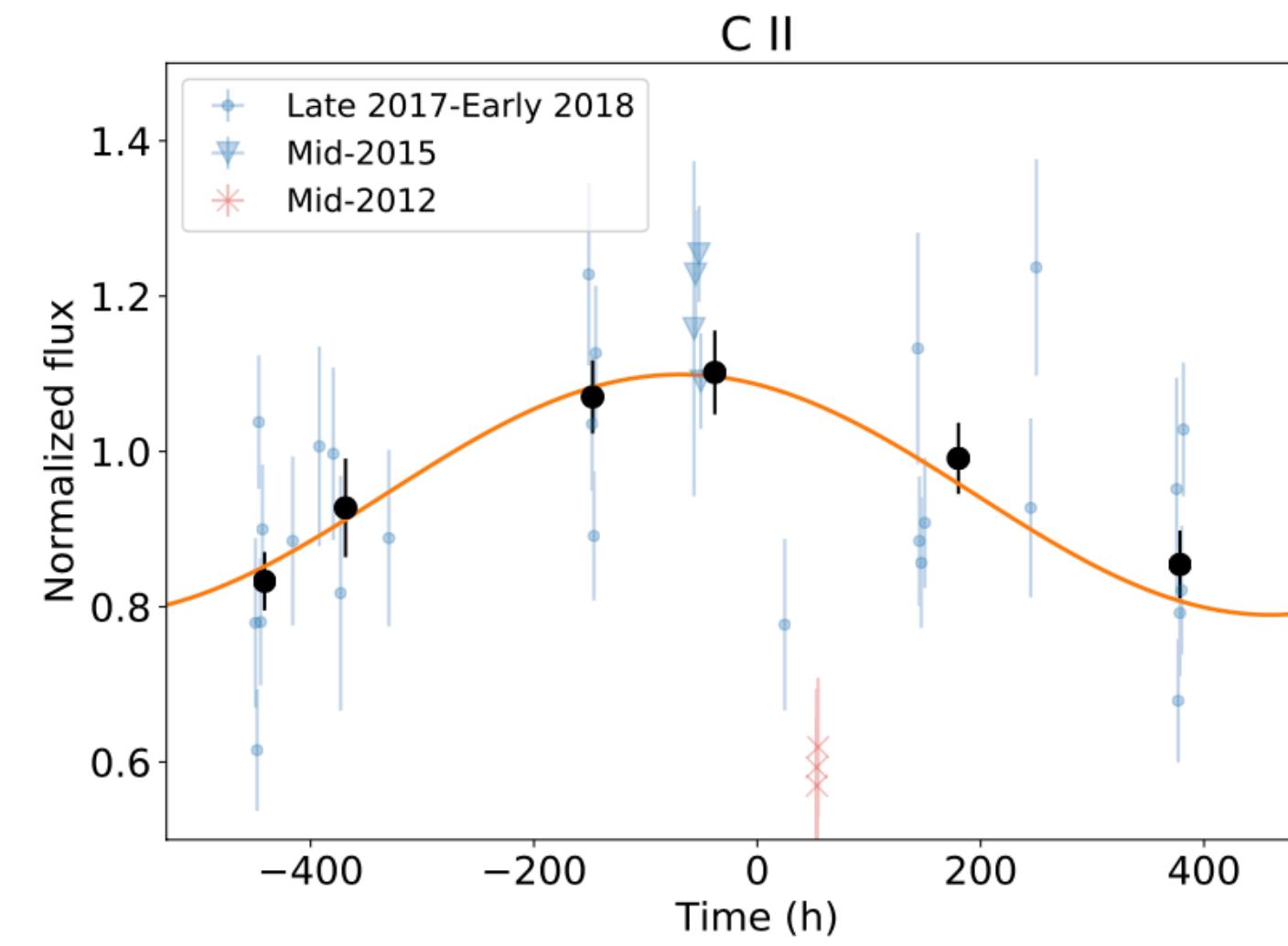
Lyman- α transit spectroscopy of HD 209458 b using HST/STIS (Vidal-Madjar et al. 2003, Nature 422)



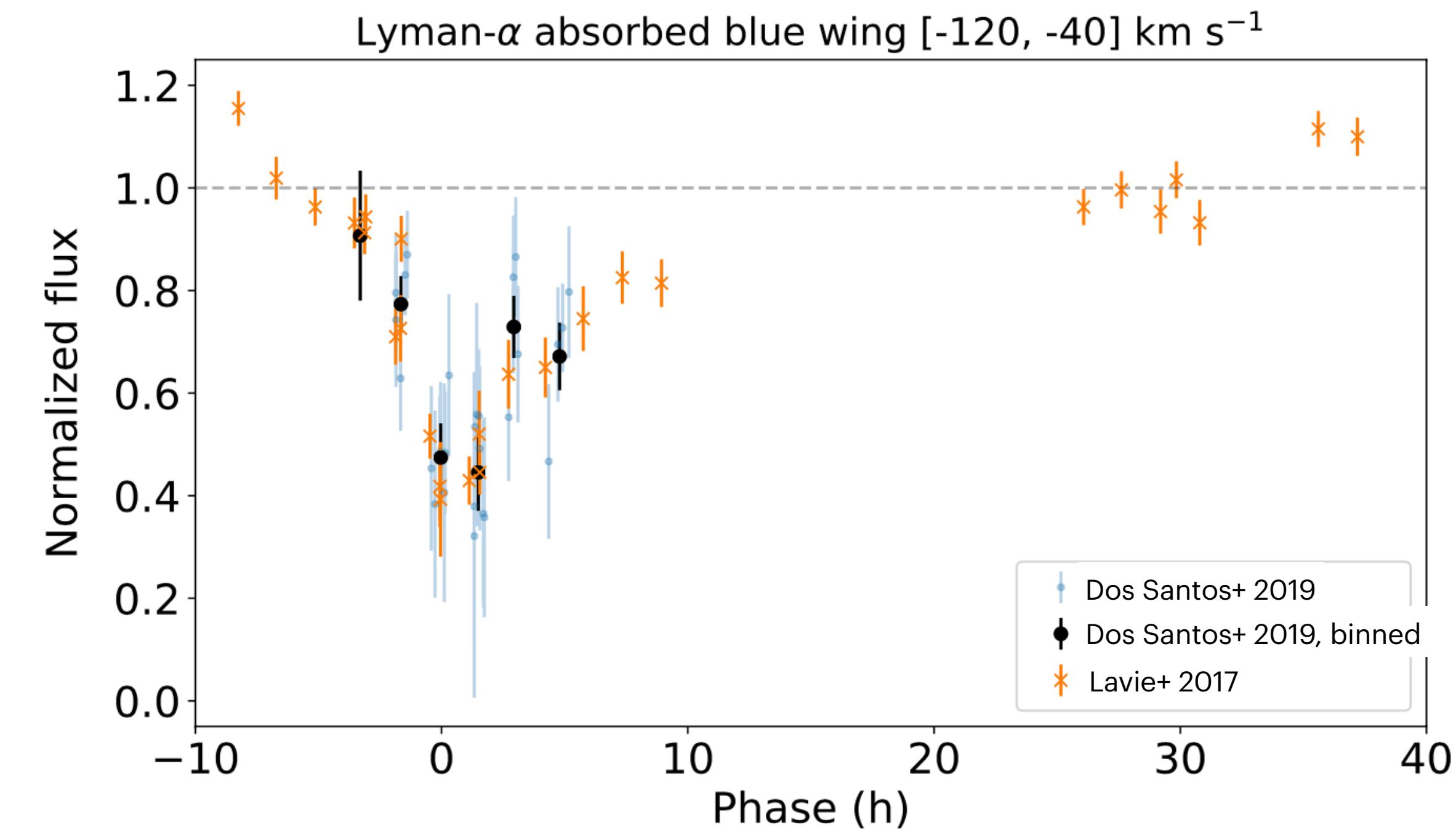
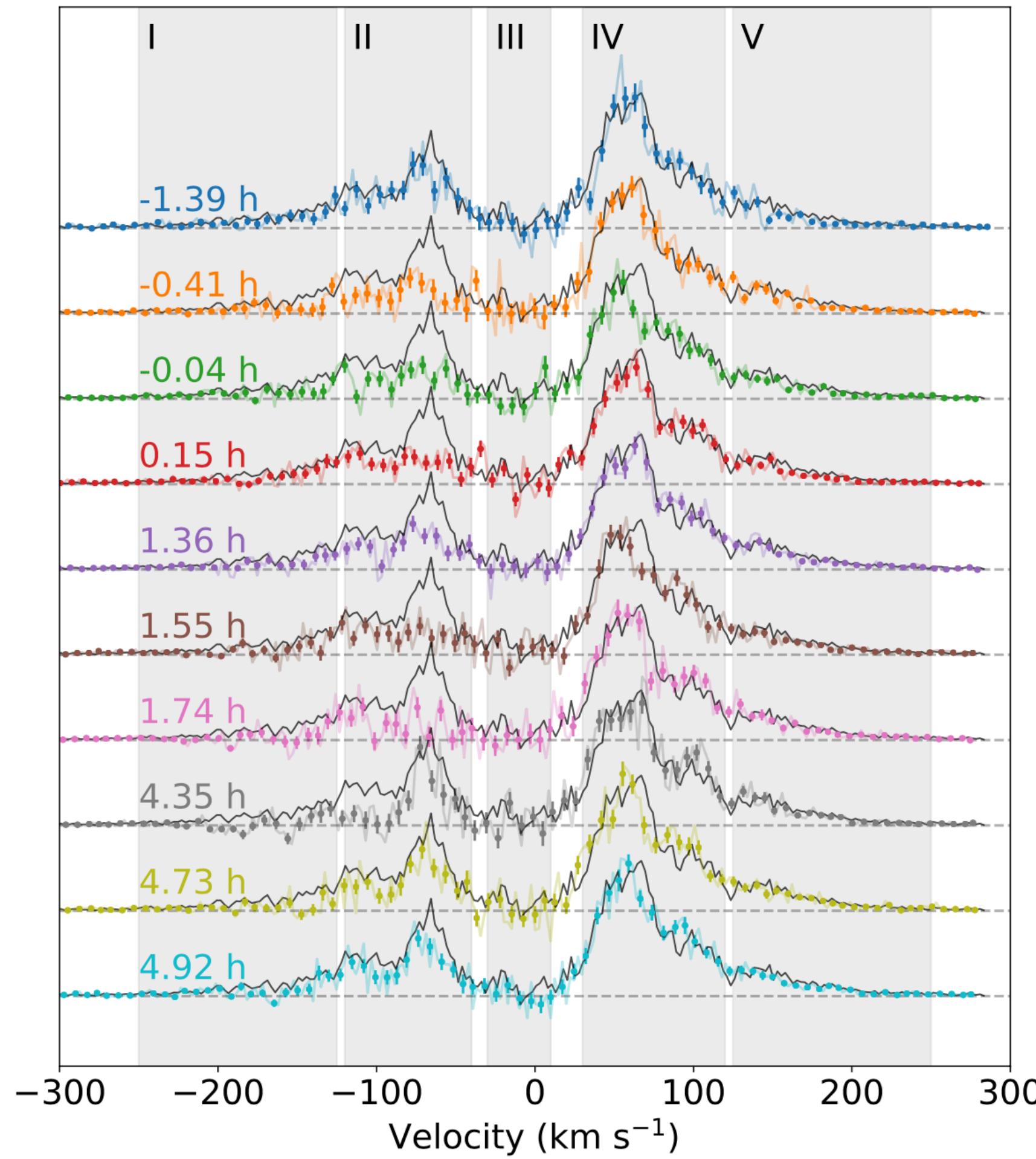
Massive atmospheric escape in GJ 436 b observed with HST/STIS (Ehrenreich et al. 2015, Nature 522)



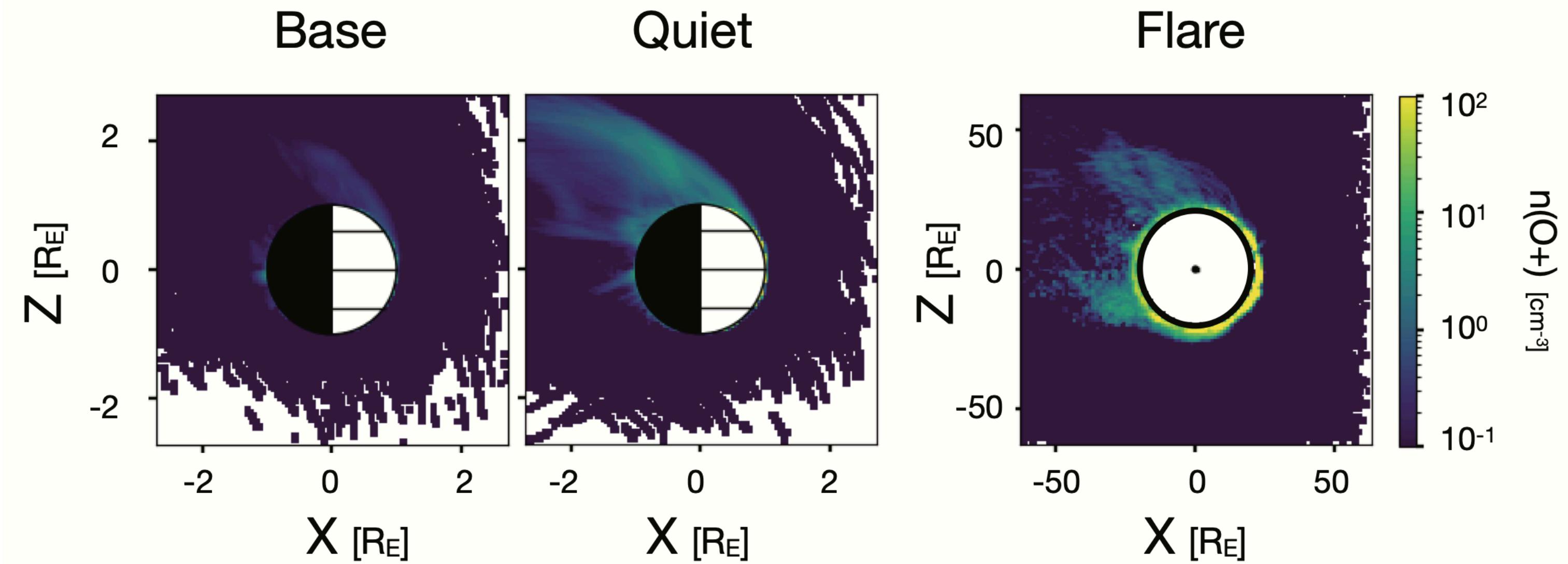
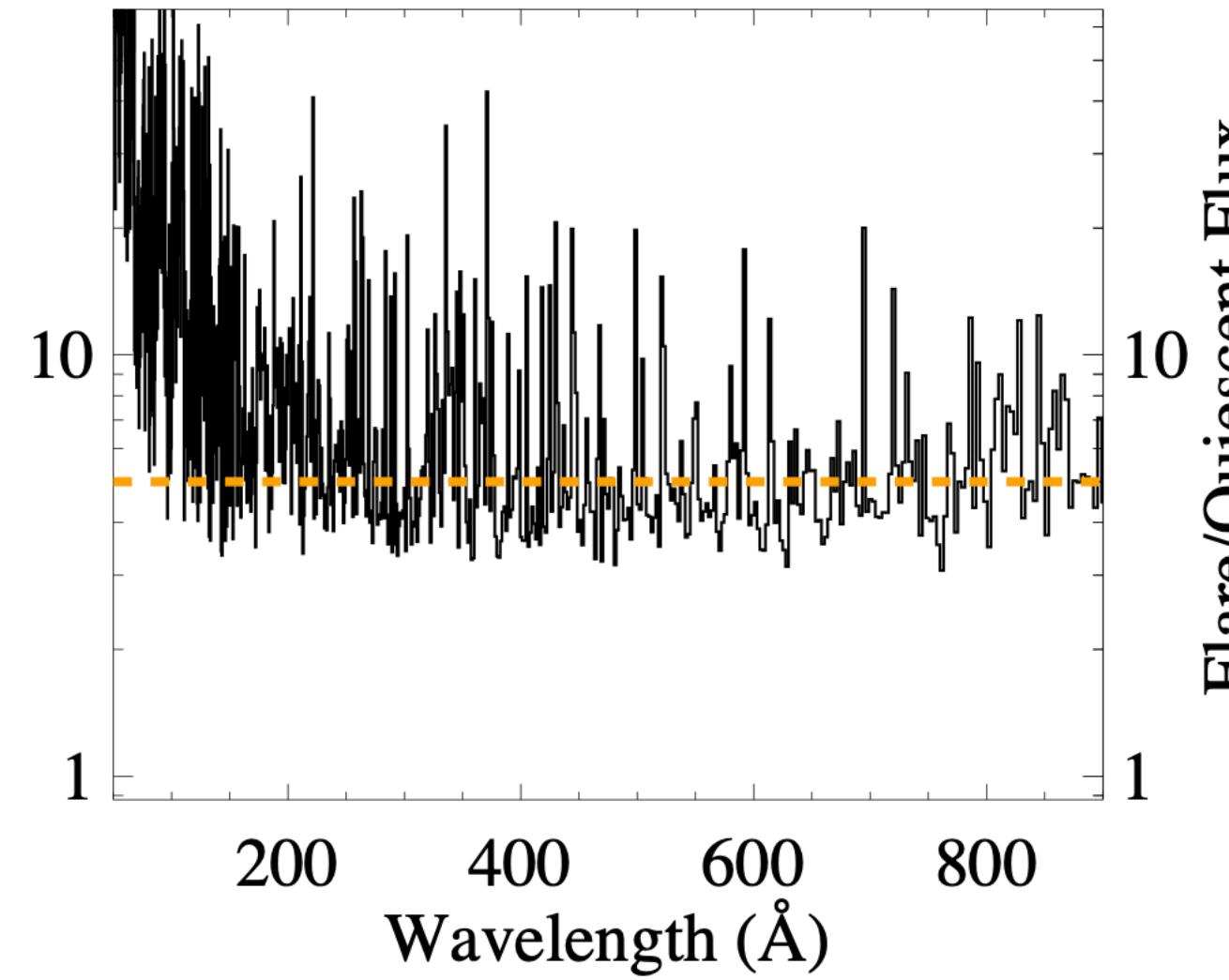
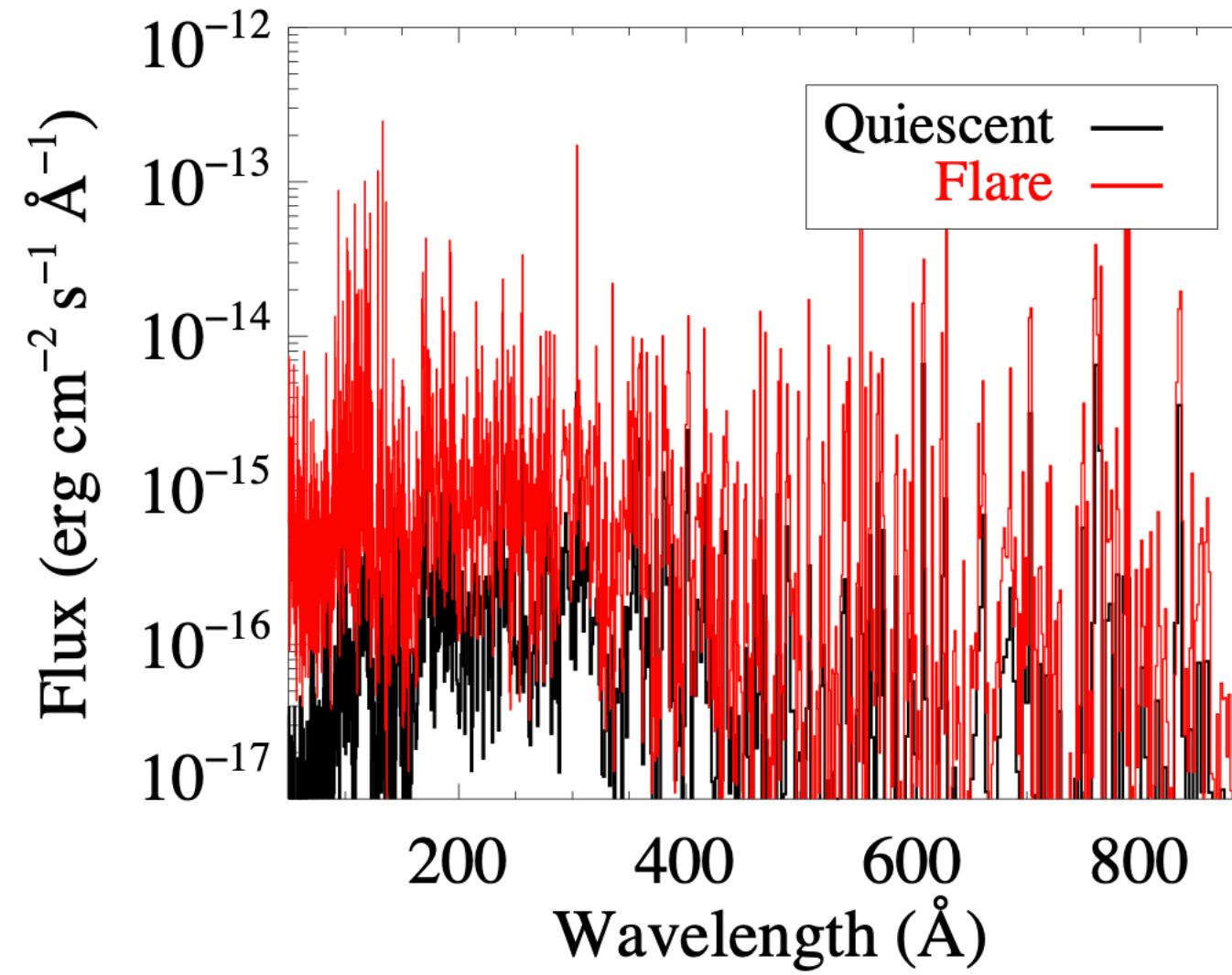
Rotational modulation of FUV fluxes of GJ 436 using *HST/COS* (dos Santos et al. 2019b, A&A 422)



Lyman- α transit spectroscopy of GJ 436 b using HST/COS (dos Santos et al. 2019b, A&A 422)

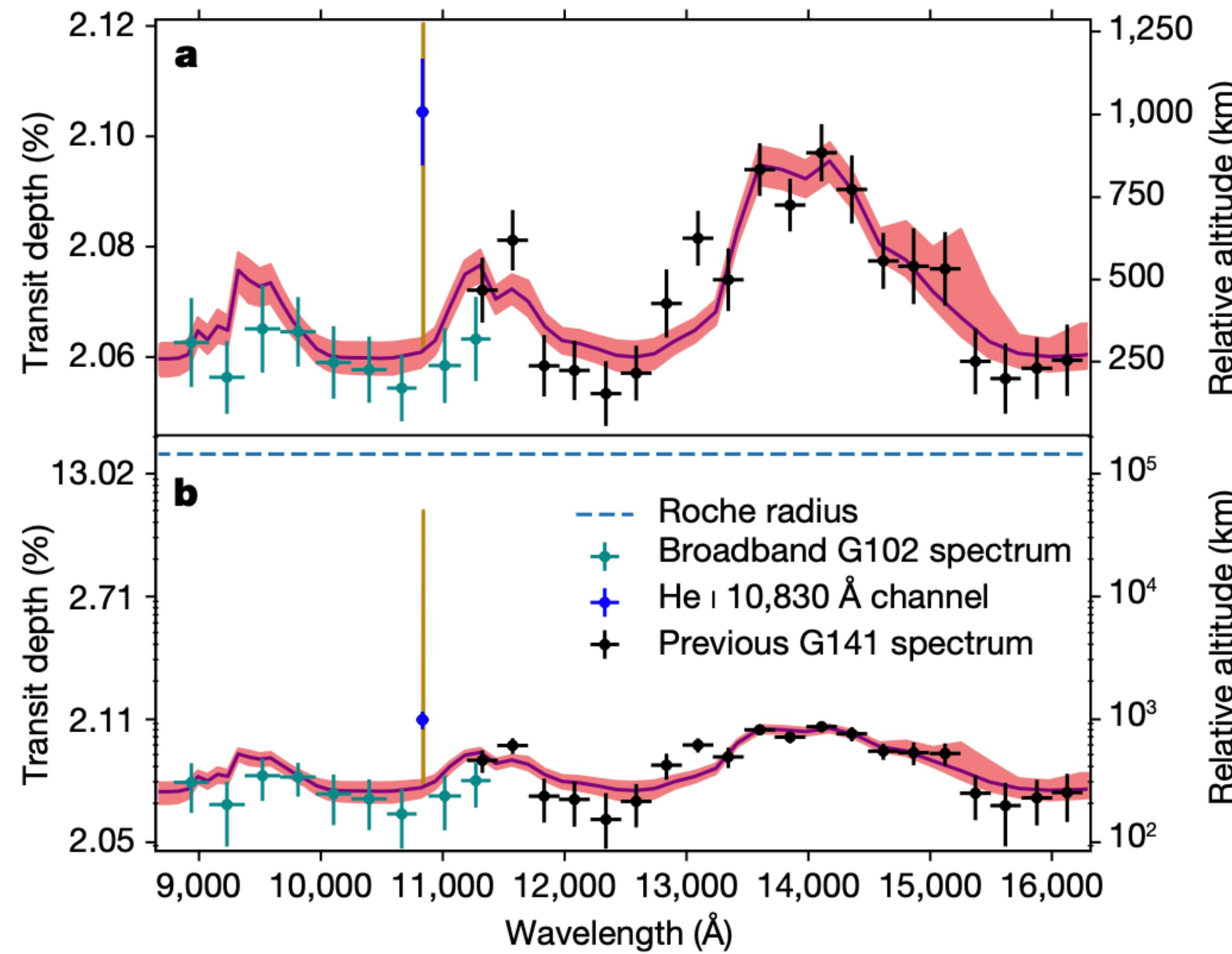


High-energy activity around Barnard's Star (France et al. 2020, arXiv:2009.01259)

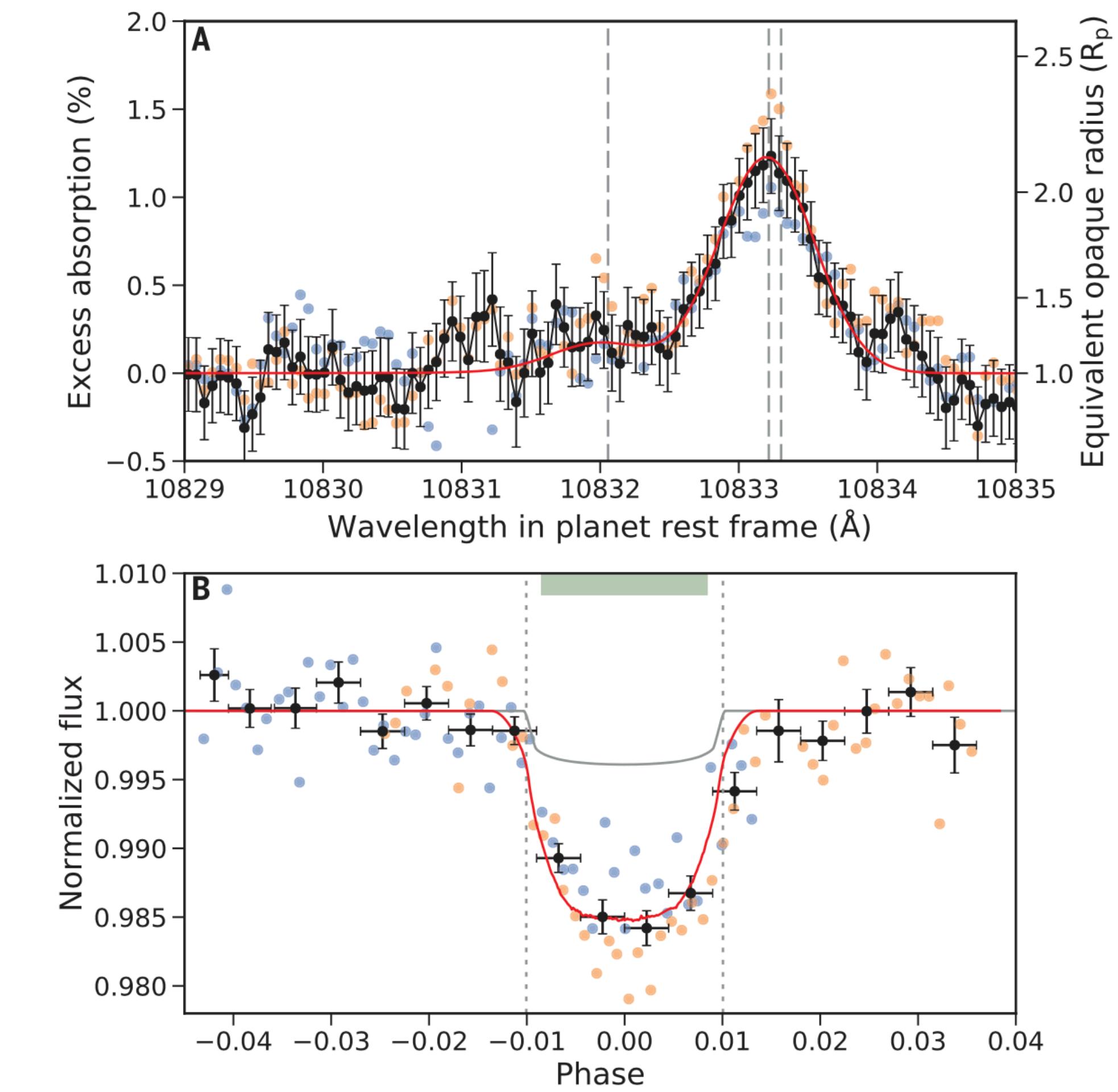


Helium $1.083 \mu\text{m}$ transit spectroscopy

WASP-107 b with *HST/WFC3* (Spake et al. 2018, *Nature* 557)



HAT-P-11 b with CARMENES (Allart et al. 2018, *Science* 362)



**Non-exhaustive list of instruments currently
capable of $1.083 \mu\text{m}$ transit spectrophotometry:**

HST/WFC3

CAHA 3.5 m/CARMENES

TNG/GIANO

Keck/NIRSPEC

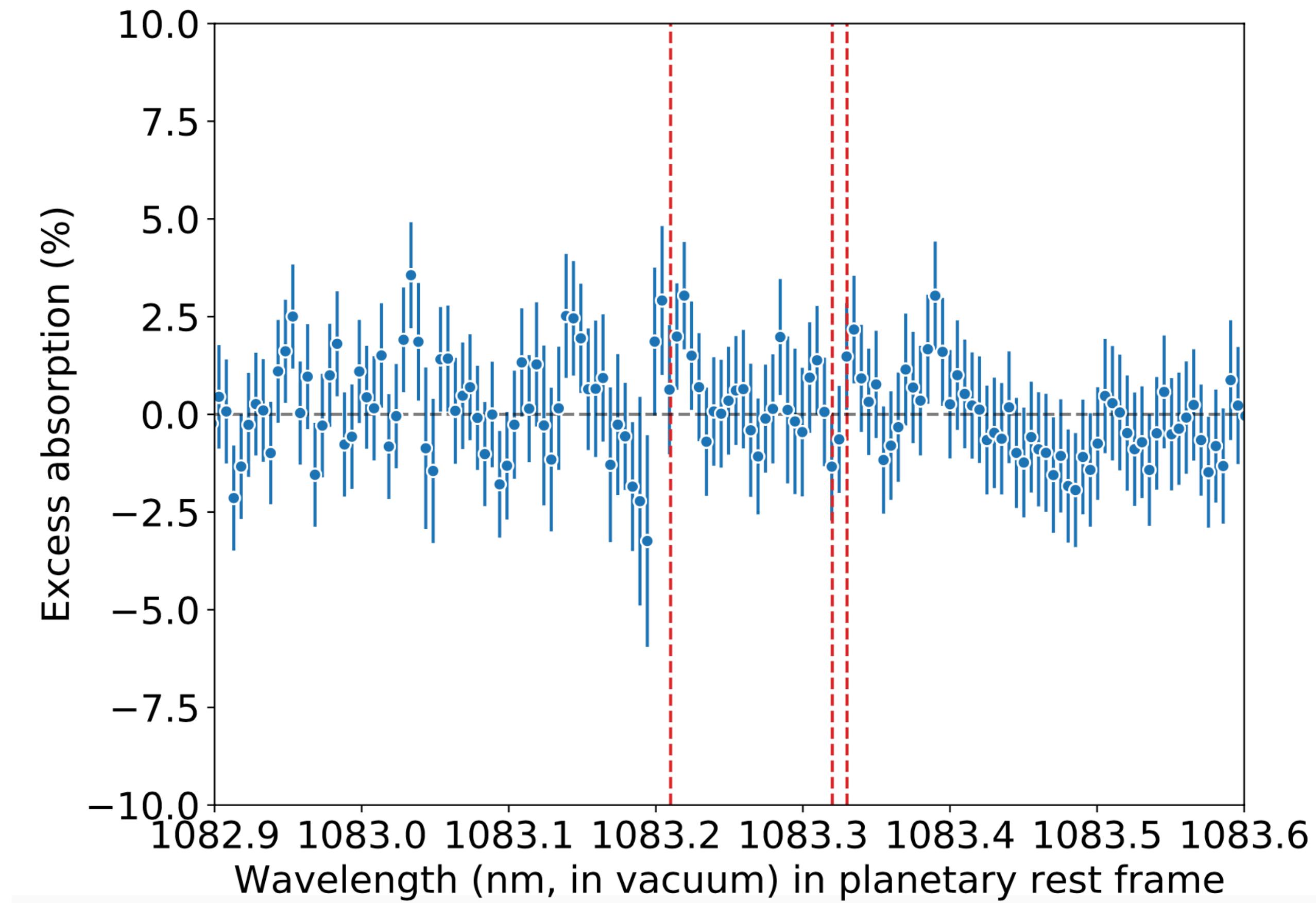
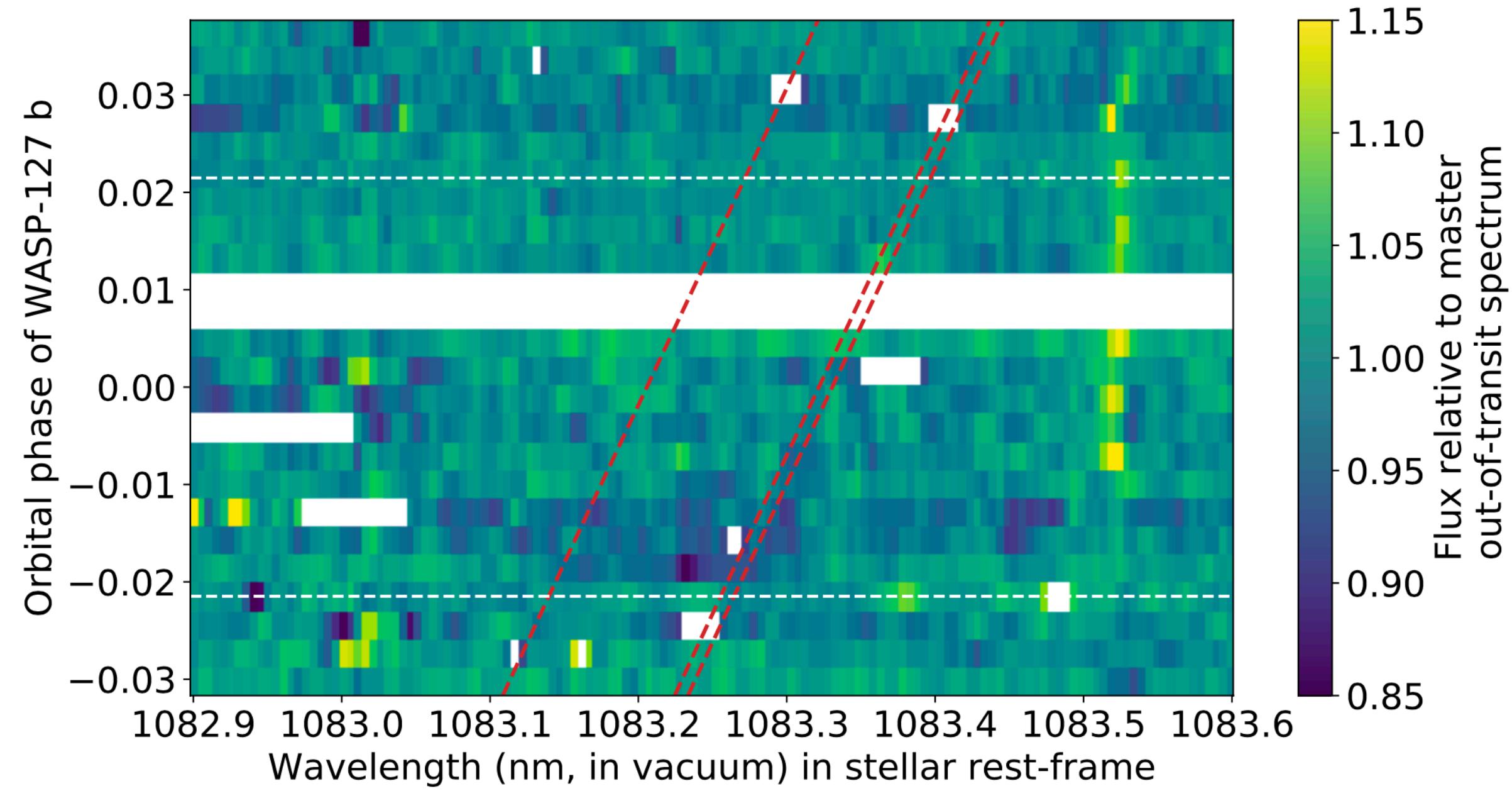
Subaru/IRD

HET/HPF

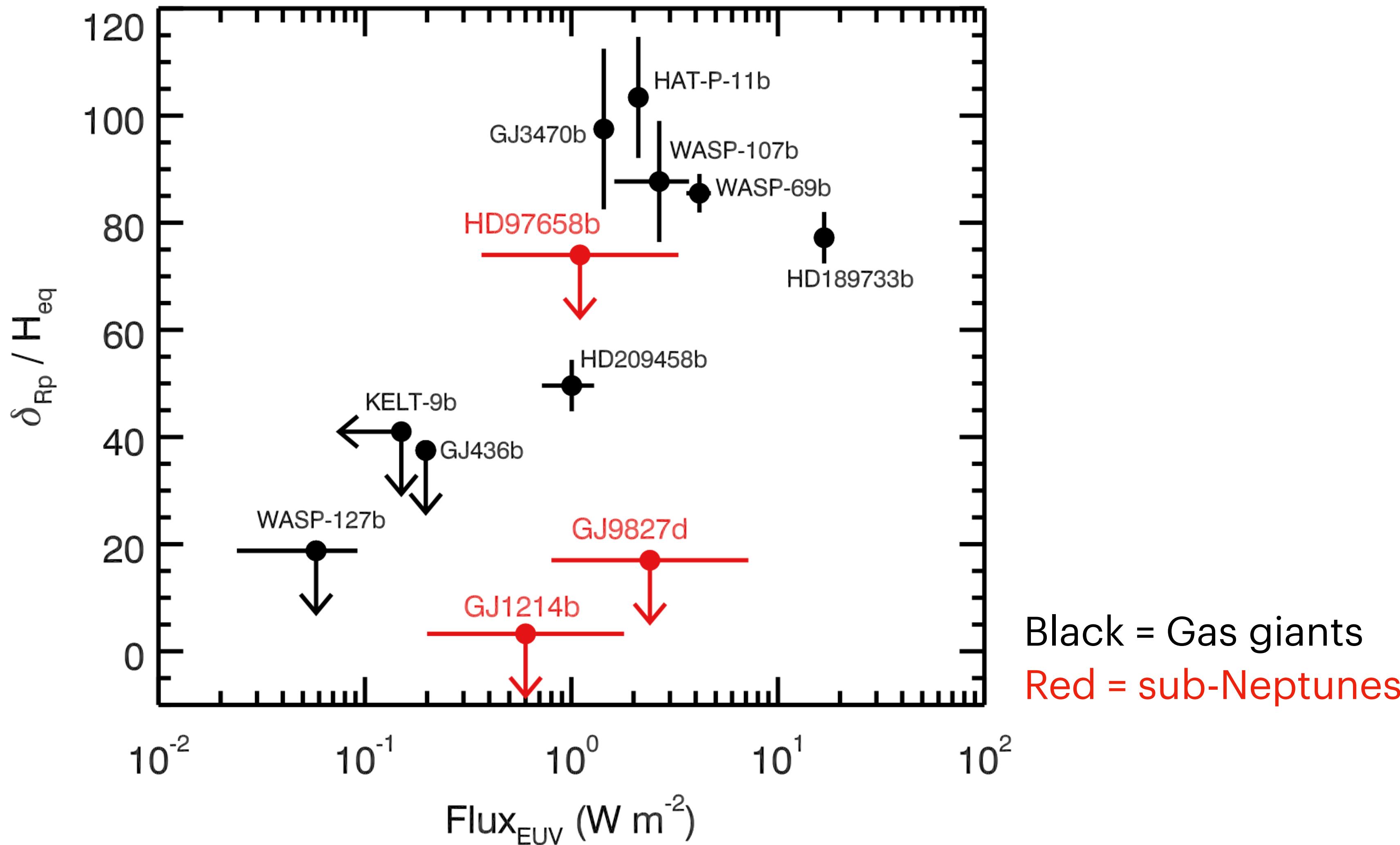
Palomar/WIRC

Gemini South/Phoenix

Non-detection of helium in transmission in WASP-127 b (dos Santos et al. 2020b, A&A 640)

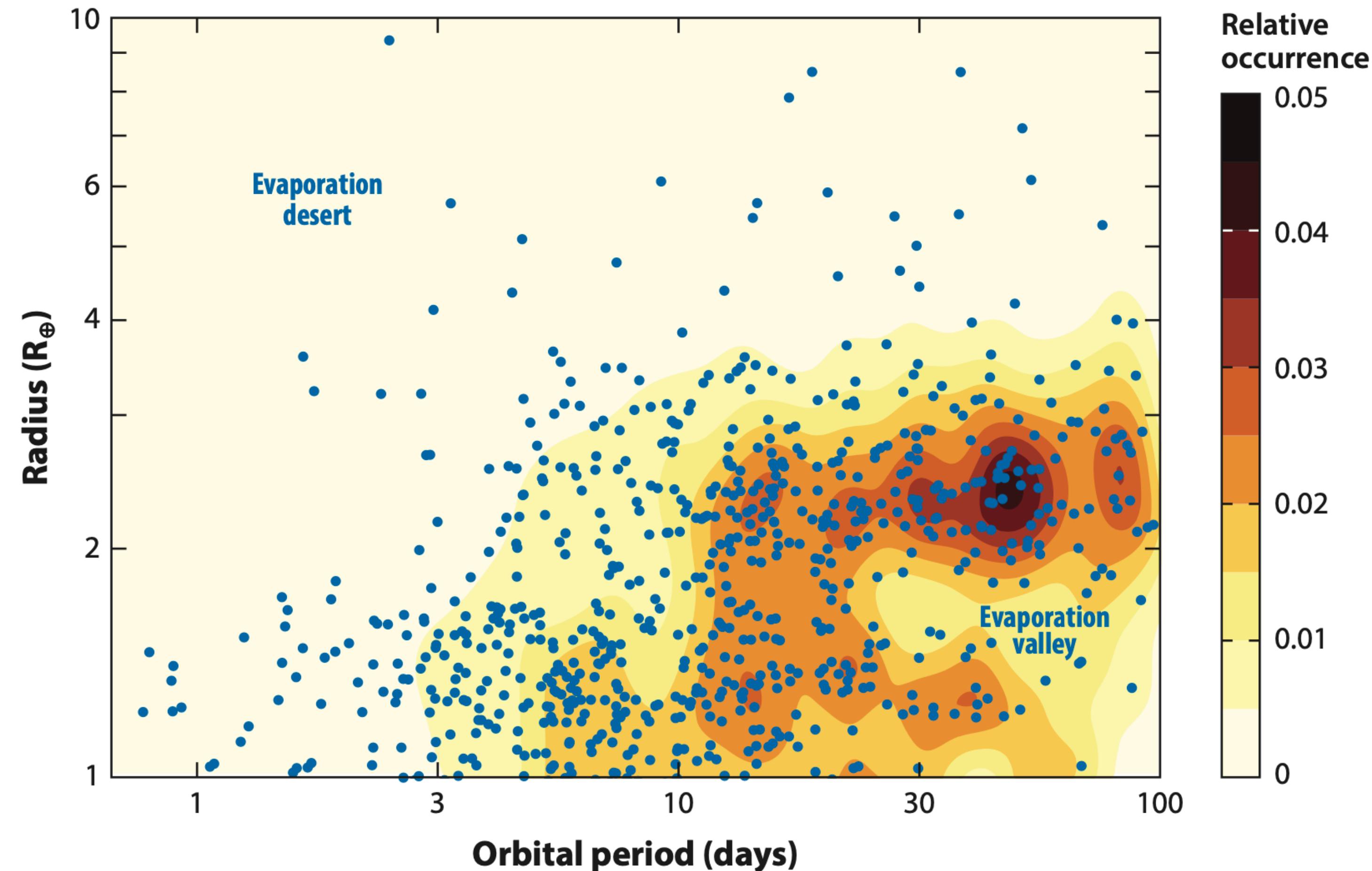


Detections and non-detections of atmospheric He (Kasper et al. 2020, AJ in press)



Atmospheric escape imprints features in the exoplanet population

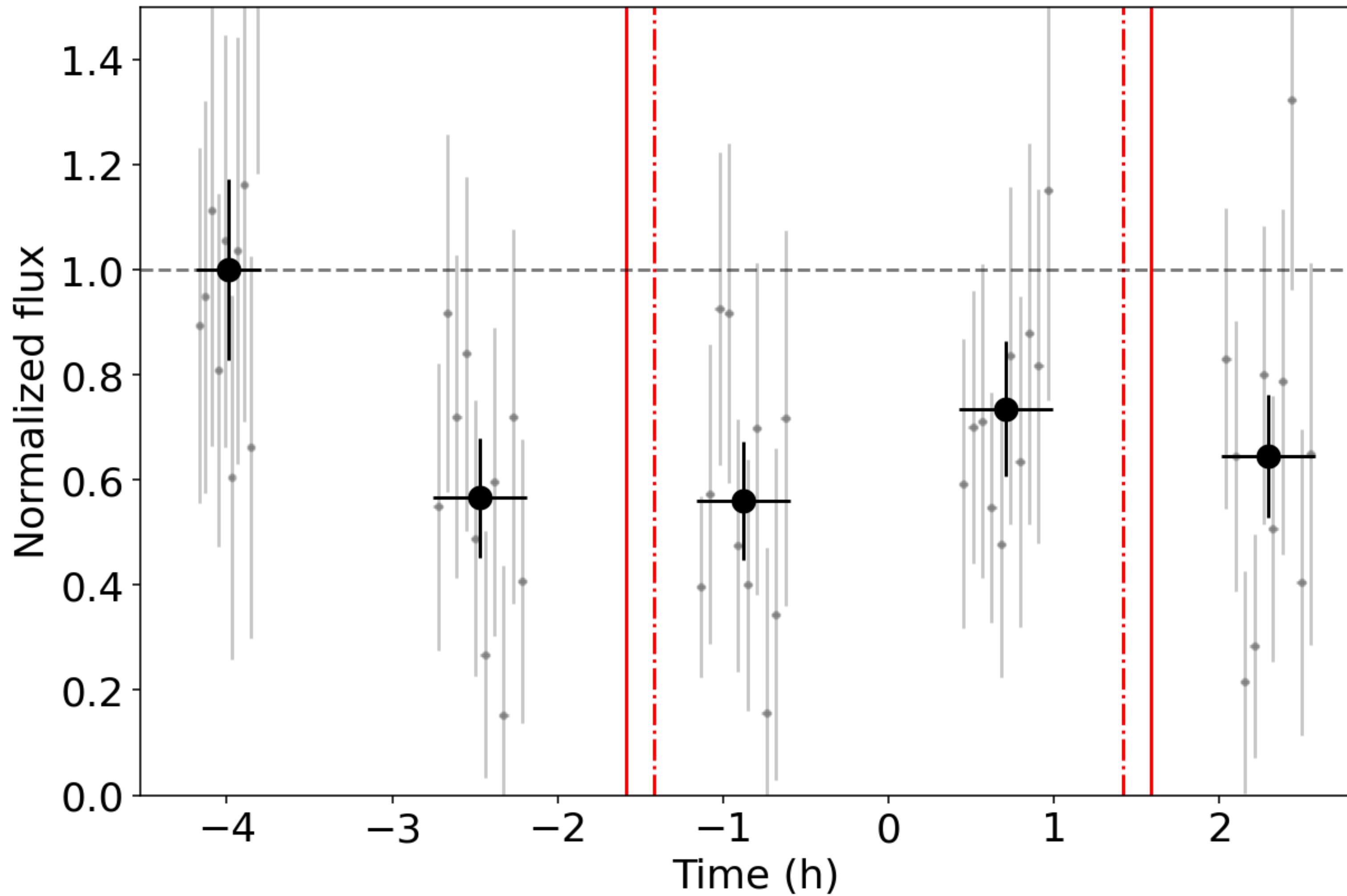
Owen (2019), Annual Review of Earth and Planetary Sciences 47



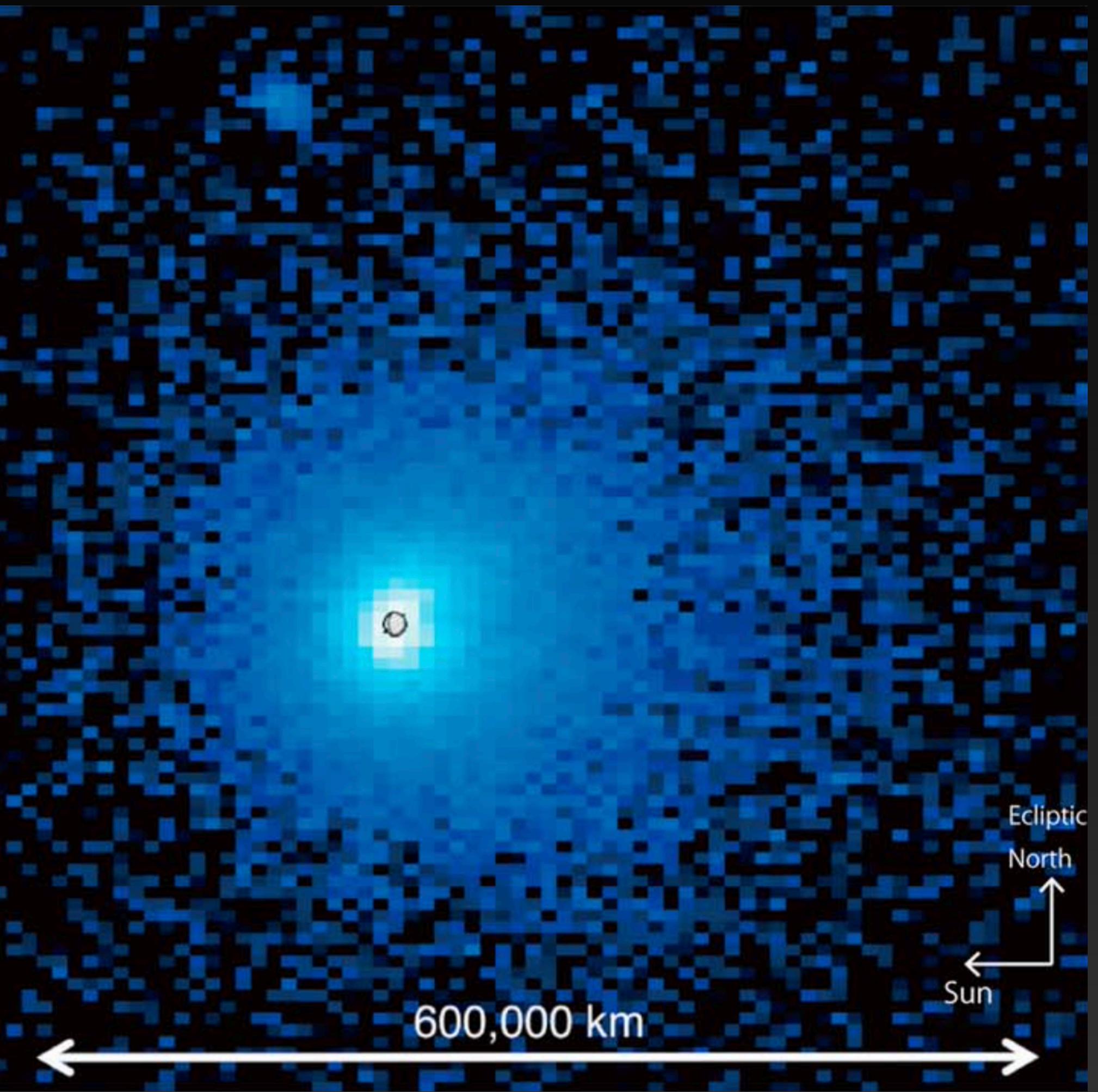
Sneak-peek preview

Danger!
Preliminary results!

Atmospheric escape in the young warm Neptune DS Tuc A b (dos Santos et al. in prep.)



**More results for young transiting
planets coming soon!**



The H-rich exosphere of the Earth observed from space.
Kameda et al. (2017), GRL 44.

LUVOIR will be able to detect Earth-like exospheres (dos Santos et al. 2019a, A&A 622)

